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14. ABSTRACT
Posttraumatic stress disorder (PTSD) has been associated with comorbidity of many somatic and mental disorders. Such psychiatric comorbidity poses increased treatment challenges for a military population that already tends to underutilize treatment services. Further, the prevalence and pattern of these comorbidities within the total force are unknown. Although some of these comorbidities may be associated with combat-related traumas, others may be more associated with separate noncombat risk and protective factors such as childhood trauma, cognitive abilities, sociodemographic factors, or genetic factors. Because different patterns may represent different underlying etiologies, optimal intervention and treatment efforts need to take them into account. These efforts require two concurrent lines of investigation: (a) identification of multiple patterns of disorders, and (b) examination of risk and protective factors for each disorder pattern. This study is the first to examine both critical lines of investigation in the total force. To conduct this unique investigation, we conducted in-depth secondary analyses of two comprehensive parallel datasets that together provide key information on PTSD symptoms and other risk behaviors for the total force, both active duty and reserve components. Findings from the analyses were presented at professional association meetings, in annual reports, in briefings to military leadership, and in several peer-reviewed papers.

15. SUBJECT TERMS
Posttraumatic stress disorder; military; population-based survey; epidemiology; comorbidity

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INTRODUCTION

The overriding goal of the research is to develop models of posttraumatic stress disorder (PTSD) risk from a wide array of deployment, stress, trauma, and mental health factors. The development of these models will guide future research hypotheses and interventions. Two specific aims were addressed: (1) identify the underlying structure of co-occurring PTSD with substance use and mental disorders among active duty (AD) and reserve component (RC) military personnel, and (2) examine variation in the underlying structure across subgroups defined by military characteristics (e.g., Service, deployment experience, pay grade) and individual characteristics (e.g., psychosocial stressors, age, race/ethnicity, gender, education). Pursuit of aims 1 and 2 advance our understanding of the prevalence of co-occurring disorders with PTSD, and how individual and military factors may influence both the risk of PTSD and co-occurring mental and substance use disorders. Past efforts have typically examined PTSD with little consideration of other mental and substance use disorders that may contribute to its onset, duration, and disability. Such information aids in the prevention and treatment of PTSD. These aims were accomplished using in-depth secondary analyses of two comprehensive parallel datasets that together provide key information on PTSD symptoms and other risk behaviors for the total force, both AD and RC. The datasets were the 2005 DoD Survey of Health Related Behaviors among Active Duty Military Personnel (16,146 respondents) and the 2006 DoD Survey of Health Related Behaviors in the Reserve Component (18,342 respondents). Methods of analysis consisted of multivariate modeling techniques. Two analytic approaches were used to address the study objectives: one evaluating models based on profiles or patterns of comorbid disorders and the other examining the relations among risk factors and observed patterns. Findings from the analyses were presented at professional association meetings, in annual reports, in briefings to military leadership, and in five peer-reviewed papers. Literature reviews were completed for all manuscripts, statistical analyses completed, three papers have been published and 2 are under review. While the previous annual report discussed tasks within each study objective, as requested, the present report describes progress to date for each individual study task outlined in the Statement of Work.

BODY

Task 1: Finalize analysis plan and obtain regulatory approvals (Months 1-2)

The first 2 months after the grant was awarded were spent establishing approvals and waivers before beginning data analysis and manuscript development. The team also completed the nonsensitive data use agreement (DUA) and submitted the agreement to TRICARE Management Activity (TMA). IRB exemptions were obtained before proceeding with analysis and manuscript development with the datasets. Individual lead authors developed initial analysis plans and created their datasets from merged active duty surveys and/or reserve component survey data as needed.

Task 2: Conduct analyses and prepare first paper (Months 2-5)

The initial paper in this investigation undertook a confirmatory factor analysis of the PCL-C to evaluate the structure of PTSD symptomatology in the military population as a whole. Literature reviews, statistical analyses, models, and tables were developed for the manuscript entitled "Measurement Invariance of Posttraumatic Stress Disorder Symptoms Among U.S. Military Personnel." Drafts were prepared and reviewed. Revisions were requested by the journal and completed by the authors. This paper found that a four-factor model consisting of re-experiencing, avoidance, emotional numbing and arousal factors best described the actor structure of the PCL-C across deployment subgroups. This paper was published in the *Journal of Traumatic Stress* and is appended to this report (see Appendix 1).

Task 3: Conduct analyses and prepare second paper (Months 6-9)

The second paper completed in this investigation examined the relationship between PTSD, substance use, and risk-taking behaviors. The literature was reviewed, statistical analyses were conducted, and manuscript drafts were reviewed. This paper, entitled "Post-Deployment Alcohol Use, Aggression, and PTSD Symptoms," found that prevalence rates for alcohol use increased in both RC and AD personnel as PCL scores increased. For AD personnel, reports of verbal and physical aggression were highest when PCL scores were at or above 50. Among RC personnel, verbal aggression and risk taking/impulsiveness, were highest when PCL scores were between 44 and 49, while the highest incidence of physical aggression and drug use were reported when PCL scores were at or above 50. This paper was accepted to *Military Medicine* for publication in the September 2012 issue (see Appendix 2).

Task 4: Conduct analyses and prepare third paper (Months 10-13)

The third paper has compared mental health indicators between RC and AD personnel on selected sociodemographic, deployment, and combat exposure variables. The literature was reviewed, statistical analyses conducted, and manuscript drafts were reviewed. This manuscript, entitled "Prevalence of Perceived Stress and Mental Health Indicators among Reserve-Component and Active-Duty Military Personnel," found that deployment had a greater impact on reservists than on AD personnel and that deployed reservists had higher rates of PTSD and

suicidal ideation and attempts than deployed AD personnel. This paper was published in the *Journal of the American Medical Association* (see Appendix 3).

Task 5: Conduct analyses and prepare fourth paper (Months 14-17)

Two additional papers were submitted for publication and reviewed. Both required revisions and are under review. In the fourth paper, the relationship between PTSD and tobacco use, and alcohol use is examined while controlling for sociodemographic factors, combat exposure, and deployment. This manuscript, entitled "Tobacco and Alcohol Abuse Correlates of Posttraumatic Stress Disorder in Active Duty and Reserve Component Military Personnel," showed a statistically significant interaction between smoking and heavy drinking when modeling the risk for PTSD in active duty personnel but not for reservists. In particular, there was an increased risk for PTSD among current smokers compared to never smokers regardless of heavy drinking status for both active duty and reserve component personnel, although differences were observed between personnel types in heavy drinking status group contrasts. This manuscript was revised and resubmitted for publication. The revised manuscript is shown in Appendix 4.

A fifth and key paper in this investigation was prepared, entitled "Patterns of Comorbidity for PTSD and Other Psychiatric Disorder among Military Personnel"; it was presented at the Military Health Research Forum 2009 in Kansas City, MO and at the American Public Health Association annual meeting on November 1, 2011 (please see Appendix 6). Findings showed that 32% of personnel who met screening criteria for PTSD also met criteria for at least one of five other mental health problems. Latent class analysis models identified five classes of PTSD comorbidity among deployed personnel and four classes among nondeployed personnel. Revisions to this paper were made in response to comments and resubmitted to the *Journal of Traumatic Stress* for review (Appendix 5).

Task 6: Project management and reporting (Months 1-18)

Project management activities have included the following:

- Project funds were tracked by the PRESTO (Project Estimating Tool) fiscal planning system each month. PRESTO is used in conjunction with CostPoint reports by the project team to monitor all costs, as well as to plan for future costs. Labor hours and other direct monthly costs are tracked each month to maintain a balanced project budget. This monthly analysis helps expose any potential financial, technical, or schedule issues that may need to be addressed by the team.
- Manuscript progress was tracked biweekly by the project manager to ensure that sufficient progress was being made with each manuscript. A manuscript timeline was updated and distributed at each team meeting.
- Biweekly team meetings, including the entire project team, reviewed the schedule and progress of all manuscripts. The team discussed any relevant manuscript issues during team meetings. General management announcements, questions, and timeline issues were addressed during biweekly meetings.

- The project was reviewed by RTI's formal Project Review System (PRS) biannually. PRS externally reviews and monitors the project management and scientific research being conducted within the scope of the project. PRS team members are senior researchers and project managers from multiple research areas, as well as from both the finance and contracts departments. The objective of the PRS is to provide another RTI level of oversight by senior staff external to the project to ensure that our client's project goals are met and to ensure that these projects represent the highest quality of performance. The goal of the PRS is to ensure that the client receives superior-quality research, development, and technical services that meet the highest standards of professional performance, satisfy client requirements, and deliver exceptional value within the time and budget constraints of the project. The PRS did not identify any areas of concern with this project.

An extension to the period of performance was requested and granted in September to extend the research until March 31, 2010. This allowed time to complete reviews and revisions for papers to be published. In addition, as of December 17, 2010 the 2008 Health Related Behavior Survey findings were released by DoD. To increase the timeliness and relevance of the data from the remaining two papers, the team considered requesting funds to update the data of the remaining two unpublished papers with that of the new survey.

KEY RESEARCH ACCOMPLISHMENTS

To date, we have:

- Performed numerous literature searches and reviews
- Conducted extensive bivariate and multivariate analyses
- Drafted five complete manuscripts, published three, and submitted two others for review.

REPORTABLE OUTCOMES

Manuscripts:

(1) Mansfield, AJ, Williams J, Hourani LL. Measurement invariance of posttraumatic stress disorder symptoms among U.S. military personnel. (2010) *Journal of Traumatic Stress*, 23, 91-99.
(2) Brown JM, Williams J, Bray RM, Hourani L. Post-Deployment alcohol use, aggression, and posttraumatic stress disorder. (2012) *Military Medicine*, in press.
(3) Lane ME, Hourani LL, Bray RM, Williams J. Prevalence of Perceived Stress and Mental Health Indicators among Reserve Component and Active Duty Military Personnel. (2012). *American Journal of Public Health*, 102, 1213-1220.
(4) Reyes Guzman CM, Williams J, Bray RM, Spira JL, Hourani LL. Tobacco and Alcohol Abuse Correlates of Posttraumatic Stress Disorder in Active Duty and Reserve Component Military Personnel. (2012). Submitted to *Addictive Behaviors*.
(5) Hourani LL, Williams J, Bray RM. Mental health and Substance abuse comorbidities of deployed and nondeployed military personnel with current PTSD symptoms. (2012) Submitted to *Journal of Traumatic Stress*.

Presentations:

(1) Hourani LL, Williams J, Bray RM. *Patterns of comorbidity of PTSD and other psychiatric disorders among Military Personnel*. Presented at the Military Health Research Forum, 2009.
(2) Hourani LL, Williams J, Bray RM. *Mental health and substance abuse comorbidities of deployed and nondeployed military personnel with current PTSD symptoms*.
(3) Lane ME, Hourani LL, Bray RM, Williams J. *Prevalence of Perceived Stress and Mental Health Indicators among Reserve Component and Active Duty Military Personnel*. (2012). To be presented at the Governor's Focus on Servicemembers, Veterans, and their Families on October 25, 2012.

CONCLUSION

The wars in Iraq and Afghanistan are producing a new generation of military personnel who are at risk of developing comorbid serious mental health problems, including chronic stress disorders and substance use disorders. This research is innovative in conducting the first in-depth modeling of the AD and RC (for whom extremely limited information exists) that are generating key hypotheses and preliminary data for proposed new studies and interventions related to PTSD. The five papers prepared document the relationships between AD and RC separately and combined across the total force of comorbidities of PTSD symptoms to guide future studies.

Findings point to an urgent need for mental health services among all service members as they face progressively stressful operations at home and abroad. For example, that deployed reservists and guardsmen reported greater PTSD symptomatology and suicidal ideation compared to non-deployed personnel suggests areas for intervention with this distinct population of service members (see Appendix 3). Further research is needed to clarify the relationships between service utilization and comorbidity patterns in these populations. These findings represent issues that are becoming increasingly salient to policymakers at all levels.

REFERENCES

See Manuscripts above.

APPENDIX 1

Measurement invariance of posttraumatic stress disorder symptoms among U.S. military personnel.

Journal of Traumatic Stress, Vol. 23, No. 1, February 2010, pp. 91–99 (© 2010)

Measurement Invariance of Posttraumatic Stress Disorder Symptoms Among U.S. Military Personnel

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Studies have not examined the factor structure or measurement invariance of posttraumatic stress disorder (PTSD) symptomatology using population-based data. Confirmatory factor analysis of the PTSD Checklist-Civilian Version (PCL-C) was conducted in a representative sample of U.S. active duty military personnel ($N = 15,593$). Consistent with prior research, a 4-factor model consisting of reexperiencing, avoidance, emotional numbing, and arousal factors was superior to four alternative models. Measurement invariance was found for factor loadings, but not observed item intercepts when comparing personnel with and without a recent deployment ($\leq$12 months). Findings indicate differences in the level of observed responses across deployment subgroups that exceed what would be expected for individuals with similar PCL latent factors scores. Implications of results are discussed.

A growing body of research has used confirmatory factory analysis (CFA) to evaluate the structure of posttraumatic stress disorder (PTSD) symptomatology. The most recent revision of the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV-TR*; American Psychiatric Association, 2000) groups 17 PTSD symptoms into three clusters: reexperiencing (Criterion B), avoidance/numbing (Criterion C), and hyperarousal (Criterion D). Unfortunately, with few exceptions (e.g., Cordova, Studts, Hann, Jacobsen, & Andrykowski, 2000; Cox, Mota, Clara, & Asmundson, 2008), prior studies have failed to support a 3-factor model matching these criteria (King, King, Orazem, & Palmieri, 2006), suggesting the existing *DSM-IV* symptom clustering, which arose from expert consensus, may not best represent the underlying structure of PTSD symptoms.

Subsequent research has endeavored to find a better-fitting model. Most studies endorse a 4-factor model first proposed by King and colleagues (King, Leskin, King, & Weathers, 1998) comprised of intercorrelated first-order reexperiencing (items B1–B5), avoidance (items C1–C2), numbing (items C3–C7), and arousal (items D1–D5) factors (Cox et al., 2008; DuHamel et al., 2004; King et al., 1998; Marshall, 2004; McDonald et al., 2008; McWilliams, Cox, & Asmundson, 2005; Naifeh, Elhai, Kashdan, & Grubaugh, 2008; Palmieri & Fitzgerald, 2005; Schinka, Brown, Borenstein, & Mortimer, 2007). An alternate correlated 4-factor model was proposed by Simms and colleagues (Simms, Watson, & Doebbeling, 2002) and supported by others (Baschnagel, O'Connor, Colder, & Hawk, 2005; Krause, Kaltman, Goodman, & Dutton, 2007; Palmieri, Weathers, Difede, & King, 2007), consisting of the same reexperiencing and avoidance factors as the King et al. model (1998), but with a different arousal factor (items D4–D5) and with a dysphoria factor (items C3–D3) replacing numbing. By grouping dysphoric symptoms, such as loss of interest in activities and sleep disturbance, this model links PTSD symptomatology more closely with models of depression and anxiety disorders among which dysphoria is a common element (e.g., Grant, Beck, Marques, Clapp, & Palyo, 2008). In contrast, the King et al. (1998) model aggregates sleep disturbance with other symptoms of heightened arousal, a more specific element of PTSD, and loss of interest with other symptoms of dulled emotional response. Support for both 4-factor models has varied across different community and clinical populations, including military and veteran groups (e.g., King et al., 1998; McDonald et al., 2008; Simms et al., 2002), with no systematic pattern suggesting idiosyncratic model-sample relationships.

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The views, opinions, and findings contained therein are those of the authors and should not be construed as an official Department of Defense position, policy or decision, unless so designated by other official documentation.

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Besides needing to clarify the latent factor structure of PTSD symptomatology, there has been a growing emphasis on exploring potential differences in factor structure and other measurement properties on the basis of age, gender, race/ethnicity, and trauma history or type (King et al., 2006; Simms et al., 2002). Although the overall symptom structure or pattern of item-factor loadings is important and has received considerable research attention, relatively few studies have examined the measurement invariance of PTSD measures across groups (McDonald et al., 2008). Put simply, measurement invariance indicates that an instrument measures a construct the same way across populations or groups (McDonald, 1999; Millsap & Kwok, 2004). To date, research examining subgroup differences in PTSD measurement has focused mainly on the invariance across English- and Spanish-speaking groups, with results suggesting little or no difference (e.g., Marshall, 2004; Miles, Marshall, & Schell, 2008; Norris, Perilla, & Murphy, 2001). Far fewer studies have examined possible differences in factor structure (i.e., factorial invariance) across military samples with varying deployment or combat history—factors that directly affect trauma history or exposure type—with equivocal results. Simms and colleagues (2002) demonstrated factor loading invariance of their 4-factor model between deployed and nondeployed veterans of the first Gulf War. More recently, McDonald and colleagues (2008) found evidence of factorial invariance in Vietnam-era and post-Vietnam-era treatment-seeking samples using the King et al. (1998) 4-factor model. However, invariance did not hold when either of these clinical samples was compared to a nonclinical group of veterans who had deployed to Iraq or Afghanistan since September 11, 2001. Furthermore, neither study explored invariance beyond the factorial (or factor loading) level, thereby ignoring the means portion of the measurement model (i.e., item intercepts and latent factor means). Lack of measurement invariance beyond the factorial level can have negative implications for across-group instrument validity and comparisons of group-specific factor scores. For example, comparing latent means for PTSD factors (e.g., reexperiencing) across groups is valid only when both factor loadings and intercepts are equivalent across groups.

Posttraumatic stress disorder among military personnel remains a widely studied topic, particularly as increasing numbers of troops report symptoms following duty in Iraq and Afghanistan (Hoge et al., 2004; Lapierre, Schwegler, & Labauve, 2007; Seal, Bertenthal, Miner, Sen, & Marmar, 2007). To date, however, potential differences in PTSD symptom structure by subgroup have not been explored in a representative military sample, nor have they fully explored the possible degrees of measurement invariance beyond factorial invariance. Current operational deployments introduce the possibility that PTSD instruments will not assess symptoms equivalently in those who have deployed relative to those who have not. This different trauma history could potentially confound results from models that assess both deployment status and PTSD symptoms.

Using a large, population-based sample of military personnel, the current study further compares the two leading 4-factor models of PTSD symptomatology and provides an in-depth consideration of measurement invariance. First, the factor structure of posttraumatic stress symptoms was examined using both the King et al. (1998) and the Simms et al. (2002) 4-factor models and comparing them to three alternative models: (a) a 1-factor model that assumes a unified structure of PTSD, (b) a 2-factor model (correlated reexperiencing/avoidance and numbing/arousal factors), and (c) a correlated 3-factor model paralleling the existing *DSM-IV* symptom criteria (American Psychiatric Association, 2000). Second, the best fitting model was then used to test measurement invariance of PTSD symptomatology across personnel with and without a deployment within the previous 12 months.

METHOD

Participants

Participants comprised a representative sample of active duty military personnel who completed a self-reported assessment of PTSD symptoms they had experienced during the previous month as part of a comprehensive study of health-related behaviors. The Department of Defense (DoD) Survey of Health Related Behaviors Among Active Duty Military Personnel (henceforth HRB survey) is a population-based study conducted periodically among U.S. military personnel stationed worldwide and includes items to assess exercise, nutrition, mental health, dietary supplement use, risk taking and impulsive behavior, job satisfaction, deployment, religion/spirituality, and alcohol and tobacco use. The eligible population for the 2005 DoD survey consisted of all active duty U.S. military personnel excluding recruits, service academy students, personnel absent without official leave (AWOL), and personnel undergoing a permanent change of station at the time of data collection. Basic trainees, academy cadets, and midshipmen were excluded because of their lack of military experience. Personnel who were either AWOL or undergoing a permanent change of station were excluded because of the difficulties associated with contacting them during the relatively short data collection period. Eligible personnel were selected using a two-stage, two-phase probability design. First-stage sampling involved random selection of military installations or ships (Navy) within service (Army, Navy, Marine Corps, Air Force) and world region (within and outside the continental United States). Second-stage sampling consisted of randomly selecting personnel at installations stratified by gender within six pay grade groups (junior, mid-level, and senior enlisted personnel; warrant officers; junior and senior commissioned officers). The sample was selected to be representative of the active duty force worldwide. Officers and women were oversampled to ensure adequate numbers for analyses. Most data (90%) were collected via anonymous, self-administered questionnaires given in group settings at military installations. The remaining

data were obtained by mail for those not attending the sessions (10%). The final sample consisted of 16,146 military personnel (3,639 Army, 4,627 Navy, 3,356 Marine Corps, and 4,524 Air Force) and reflected an overall response rate of 51.8%. Data were weighted to reflect respondents' probabilities of selection and adjusted to account for potential effects of nonresponse. Additional details on HRB survey methodology may be found elsewhere (Bray et al., 2006). Military population statistics provided by the Defense Manpower Data Center were used to poststratify the sample data to represent the target population.

Measures

Posttraumatic stress disorder symptom severity was assessed using the PTSD Checklist-Civilian Version (PCL-C; Weathers, Litz, Huska, & Keane, 1994), a 17-item self-report instrument that asks respondents to rate the extent to which they have been bothered by PTSD symptoms during the previous 30 days using a 5-point scale (1 = *not at all*, 5 = *extremely*). The PCL-C items parallel *DSM-IV* PTSD symptom Criteria B, C, and D, and a variety of studies support its use as a valid and reliable screening instrument (e.g., Keen, Kutter, Niles, & Krinsley, 2008; Ruggiero, Del Ben, Scotti, & Rabalais, 2003). Although a military version of the PCL exists (PCL-M), the HRB surveys (and other DoD studies) use the civilian version for several reasons. The PCL-M asks respondents to consider symptoms of PTSD specifically related to military experiences (Weathers, Litz, Herman, Huska, & Keane, 1993), whereas the PCL-C evaluates symptoms resulting from any past traumatic event. Assessment of PTSD symptoms from both military and nonmilitary sources is important when considering the overall mental health and readiness of military personnel (National Center for PTSD, 2004). Also, the military version misses common causes of deployment or war-related PTSD in women (e.g., sexual assault rather than combat per se), as well as deployment-related exacerbations of PTSD symptoms if the original inciting trauma is not military-related.

Data Analysis

To assess the structure of the PCL items, five confirmatory factor analysis models (Table 1) were estimated using Mplus version 5 (Muthén & Muthén, 1998). The sampling features of the data were accommodated by Mplus's robust maximum likelihood complex sample estimation, which incorporates weights for parameter estimation and uses a sandwich estimator to compute appropriate standard errors for clustered data (Asparouhov, 2005; Asparouhov & Muthén, 2005). In addition to adjusting parameter estimates and standard errors to account for the complex survey nature of the data, the maximum likelihood estimator accommodated item-level missing data without bias under the missing at random assumption (Enders, 2001; Little & Rubin, 2002). Several goodness-of-fit measures were used to evaluate the models (Brown, 2006). Indices included the standardized root-mean-square residuals (SRMR), comparative fit index (CFI), and root-mean-square error of approximation (RMSEA). Acceptable cutoffs for these indices are .08 or lower for SRMR, .95 or higher for CFI, and .06 or lower for RMSEA (Hu & Bentler, 1999). Models were also compared using the Bayesian information criterion (BIC; Schwarz, 1978), with lower values indicating better model fit.

Multiple-group confirmatory factor analysis was used to test for measurement invariance across personnel who had been deployed within the past 12 months (hereafter deployed) and those who had not (hereafter nondeployed). Degrees of observed item invariance are considered in a hierarchical fashion and are ordered as configural invariance, metric invariance, scalar invariance, and strict invariance (Steenkamp & Baumgartner, 1998; Vandenberg & Lance, 2000). Configural invariance indicates that groups perceive latent constructs (i.e., factors) in the same way, with the same factor loading pattern (Meredith, 1993; Riordan & Vandenberg, 1994). Metric invariance is achieved when factor loadings for each item are equivalent across groups and is generally

Table 1. Item Mapping for Tested Models

		Models				
DSM-IV PTSD symptom		1	2	3	4a	4b
1. B1	Intrusive thoughts	P	R, A	R	R	R
2. B2	Recurrent dreams	P	R, A	R	R	R
3. B3	Flashbacks	P	R, A	R	R	R
4. B4	Emotional reactivity	P	R, A	R	R	R
5. B5	Physical reactivity	P	R, A	R	R	R
6. C1	Avoiding thoughts of trauma	P	R, A	A	A	A
7. C2	Avoiding reminders of trauma	P	R, A	A	A	A
8. C3	Inability to recall aspects of trauma	P	R, A	A	N	D
9. C4	Loss of interest	P	N, H	A	N	D
10. C5	Detachment	P	N, H	A	N	D
11. C6	Restricted affect	P	N, H	A	N	D
12. C7	Sense of foreshortened future	P	N, H	A	N	D
13. D1	Sleep disturbance	P	N, H	H	H	D
14. D2	Irritability	P	N, H	H	H	D
15. D3	Difficulty concentrating	P	N, H	H	H	D
16. D4	Hypervigilance	P	N, H	H	H	H
17. D5	Exaggerated startle response	P	N, H	H	H	H

Note. DSM-IV = *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition Text Revision* (American Psychiatric Association, 2000); PTSD = posttraumatic stress disorder, P = general posttraumatic stress, R = reexperiencing, A = avoidance, N = numbing; H = hyperarousal (arousal), D = dysphoria. Model sources: 2 = Taylor et al. (1998); 3 = *DSM-IV-TR* (American Psychiatric Association, 2000); 4a = King et al. (1998); 4b = Simms et al. (2002).

Table 2. Goodness-of-Fit Statistics for PCL-C Models Tested Using Maximum Likelihood Confirmatory Factor Analysis

Model	Description/source	χ^2	*df*	CFI	SRMR	RMSEA	BIC
1	Single factor	4448.36	119	.89	.05	.05	537401.53
2	2-Factor (Taylor, et al., 1998)	2505.07	118	.94	.04	.04	524749.68
3	3-Factor (*DSM-IV-TR*)	2495.78	116	.94	.04	.04	525013.11
4a	4-Factor (King et al., 1998)	1628.20	113	.96	.03	.03	519334.90
4b	4-Factor (Simms et al., 2002)	1689.22	113	.96	.03	.03	519627.39

Note. PCL-C = PTSD Checklist-Civilian Version; *DSM-IV* = *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition Text Revision* (American Psychiatric Association, 2000); CFI = comparative fit index; SRMR = standardized root-mean-square residual; RMSEA = root-mean-square error of approximation; BIC = Bayesian information criterion.

held as a prerequisite for meaningful across-group comparisons based on composites or scales (Bollen, 1989). Scalar invariance occurs when item intercepts can be equated across groups and indicates that observed scores are the same for the identical underlying factor score (Cheung & Rensvold, 2002; Meredith, 1993). A meaningful comparison of latent means requires scalar invariance. Strict invariance, in which residual errors or uniquenesses are equal, is obtained when the latent factors are measured with the same degree of error by the observed items in each group, but is not generally a requirement for group comparisons (Cheung & Rensvold, 2002). Tests of group differences in PTSD symptoms may be biased or produce erroneous conclusions if measurement invariance at any of these three levels—configural, metric, or scalar—is not met.

Constraints were added to the PTSD symptom measurement models to equate parameters in the deployed and nondeployed groups and to test the degree of measurement equivalence in each PCL-C factor. Increasing levels of parameter constraints imposed configural, metric, and scalar invariance. Constrained models were nested within each previous model and tested by comparing the change in the χ^2 ($\Delta\chi^2$) to the χ^2 distribution with degrees of freedom equal to the change in free parameters (Bollen, 1989; Widaman & Reise, 1997). Because models were estimated with the robust maximum likelihood estimator, it was necessary to adjust the estimated $\Delta\chi^2$ by a test correction factor derived from the scaling factor of the likelihood estimate in each model (Satorra & Bentler, 2001). All values of $\Delta\chi^2$ presented include this scaling adjustment. For assessment of measurement invariance, Mplus version 5 (Muthén & Muthén, 1998) was also used. Invariance tests incorporated the weights from the sample, but ignored the sampling variance structure because the number of parameters in the multiple group models exceeded the number of primary sampling units and produced unstable or inadmissible (i.e., negative) estimates of $\Delta\chi^2$.

RESULTS

Of the final sample of 16,146 military personnel, 553 (3.4%) were missing four or more PCL-C items and were excluded. Individuals with a valid response to 14 or more items comprised the analysis sample ($N = 15{,}593$). The military population represented in the data had a mean age of 28.4 years ($SD = 0.3$), was mostly male (75.1%), and White, non-Hispanic (64.7%). Most had some or a completed college education (66.3%), and were married (54.0%). Just over half (56.4%) reported deployment one or more times in the previous 12 months and had a mean PCL-C score of 25.9 ($SD = 28.1$). The mean PCL-C score for personnel who did not deploy in the previous year was 25.2 ($SD = 32.2$), and was 27.7 ($SD = 19.5$) for those missing data for deployment ($n = 313$).

Analysis of Factor Structure

Results of the confirmatory factor analyses are presented in Table 2. The single-factor model (Model 1) had the poorest fit, with the lowest CFI (.89) and the highest SRMR (.05), RMSEA (.05), and BIC (537401.53). The 2-factor and 3-factor *DSM-IV* models (Models 2 and 3, respectively) showed improvement upon the single-factor model and performed similarly to one another with essentially identical fit statistics. Of the five models tested, the two 4-factor models (Models 4a and 4b) achieved the best fit overall. Models 4a and 4b were equivalent in terms of CFI (.96), RMSEA and SRMR (.03 for each), though Model 4a was slightly superior to Model 4b in terms of BIC (332347.03 vs. 332907.83).

Although a 4-factor model had better fit than models with fewer dimensions, there was considerable overlap between the four PTSD dimensions of the model. Table 3 displays the factor correlations for both 4-factor models, which ranged from .75 to .90. Table 4 presents the factor correlations for Models 4a and 4b by deployment subgroup, which ranged from .80 to .90 and from .76 to .87, respectively, among the deployed group, and from .79 to .90 and from .74 to .90 among the nondeployed group.

Measurement Invariance

The configural invariance models, in which only the pattern of factor-item loadings was equated across deployment groups, exhibited satisfactory fit that did not differ greatly from one another or from the single-group models (4a: CFI = .95, RMSEA = .03,

Table 3. Correlation Matrix of Latent Variables for 4-Factor Models

	Variables		
Model 4a	Reexperiencing	Avoidance	Numbing
Avoidance	.88	—	—
Numbing	.81	.82	—
Hyperarousal	.81	.79	.90
Model 4b	Reexperiencing	Avoidance	Dysphoria
Avoidance	.88	—	—
Dysphoria	.82	.82	—
Hyperarousal	.78	.75	.84

Note. All correlations are significant at $p < .001$. Model sources: 4a = King et al. (1998); 4b = Simms et al. (2002).

SRMR = .03; 4b: CFI = .95, RMSEA = .03, SRMR = .03). Since Models 4a and 4b exhibited nearly identical fit, both were examined for measurement invariance, as the level of measurement equivalence across groups might ultimately be the deciding factor in model choice. Using both 4-factor models, the measurement properties of the PCL-C were compared in deployment subgroups. The deployed group included personnel who had deployed within the previous 12 months, and were therefore more likely to experience combat stressors and trauma events unlike those experienced by the nondeployed group. Model 4a showed invariance at the metric level with $\Delta\chi^2$ (13) = 6.49, *ns*. However, constraining PCL-C intercepts to be equivalent in deployed and nondeployed groups significantly worsened fit: $\Delta\chi^2$ (13) = 68.71, $p < .001$. Model 4b showed a similar pattern of invariance at the metric level, with $\Delta\chi^2$ (13) = 15.18, *ns*, but not at the scalar level, where $\Delta\chi^2$ (13) = 71.21, $p < .001$.

Following the failure to find scalar invariance in the complete models with all factors constrained to equivalence, each of the individual factors were examined for invariance using the configural model as the referent. Reexperiencing and avoidance used the configural model of Model 4a as the baseline model; all other factors used the model for which they were pertinent (e.g., dysphoria used Model 4b as its baseline). This strategy was analogous to explorations of partial invariance (Byrne, Shavelson, & Muthen, 1989; Millsap & Kwok, 2004) in which variant and invariant components are identified and the source of overall invariance isolated. Each of the PCL-C factors followed the same pattern as the complete model, with individual factor loadings passing the metric invariance test, but not the scalar test (Table 5). Thus, for each factor, observed item scores in the deployed and nondeployed groups would not be equal for comparable levels of the underlying factor. Put another way, the responses of deployed and nondeployed personnel to the PCL-C differ as a result of some other influence, independent and separate from the underlying latent factors of reexperiencing, avoidance, numbing, and hyperarousal.

DISCUSSION

This study explored the underlying structure of PTSD symptomatology using the PCL-C by examining five proposed factor solutions using confirmatory factor analysis in a large, population-based military study. King et al.'s (1998) 4-factor model comprised of reexperiencing, avoidance, emotional numbing, and arousal offered the best fit compared to 1-, 2-, and 3-factor models, and a competing, theoretically derived 4-factor model from Simms et al. (2002). Both 4-factor models were superior to models comprised of fewer factors, including the original 3-factor *DSM-IV* conceptualization of symptom groups, and others supported by earlier research (Buckley, Blanchard, & Hickling, 1998; Cordova et al., 2000; Taylor, Kuch, Koch, Crockett, & Passey, 1998). Overall model fit was very similar between King et al.'s (1998) numbing-arousal and Simms et al.'s (2002) dysphoria-arousal models,

Table 4. Correlation Matrix of Latent Variables for 4-Factor Models by Deployment Subgroup

	Variables			
Model 4a	Reexperiencing	Avoidance	Numbing	Hyperarousal
Reexperiencing	—	.90	.79	.80
Avoidance	.87	—	.81	.79
Numbing	.82	.82	—	.89
Hyperarousal	.82	.80	.90	—
Model 4b	Reexperiencing	Avoidance	Dysphoria	Hyperarousal
Reexperiencing	—	.90	.81	.74
Avoidance	.87	—	.82	.74
Dysphoria	.82	.82	—	.83
Hyperarousal	.80	.76	.84	—

Note. Upper diagonal of each matrix corresponds to nondeployed group, lower diagonal corresponds to deployed group. Model sources: 4a = King et al. (1998); 4b = Simms et al. (2002). All correlations are significant at $p < .001$.

Table 5. Goodness-of-Fit Statistics for PCL-C Models, Deployed Versus Nondeployed

	Robust maximum likelihood estimator			
	χ^2	*df*	$\Delta\chi^2$	Δdf
Full model (4a)				
Configural	1730.88	226		
Metric (λ invariance)	1749.20	239	6.49	13
Scalar (λ and τ invariance)	1829.30	252	68.71***	13
Full model (4b)				
Configural	1790.19	226		
Metric (λ invariance)	1805.37	239	15.18	13
Scalar (λ and τ invariance)	1876.58	252	71.21***	13
Factor-specific models				
Reexperiencing (4a as configural model)				
Metric (λ invariance)	1731.87	230	0.31	4
Scalar (λ and τ invariance)	1753.41	234	18.13**	4
Avoidance (4a as configural model)				
Metric (λ invariance)	1732.81	227	0.83	1
Scalar (λ and τ invariance)	1739.28	228	5.53*	1
Numbing (4a as configural model)				
Metric (λ invariance)	1736.24	230	1.84	4
Scalar (λ and τ invariance)	1760.12	234	20.71***	4
Hyperarousal (4a as configural model)				
Metric (λ invariance)	1741.17	230	4.20	4
Scalar (λ and τ invariance)	1771.52	234	26.50***	4
Dysphoria (4b as configural model)				
Metric (λ invariance)	1800.68	233	3.99	7
Scalar (λ and τ invariance)	1840.59	240	34.74***	7
Hyperarousal (4b as configural model)				
Metric (λ invariance)	1791.70	227	0.55	1
Scalar (λ and τ invariance)	1796.51	228	4.12*	1

Note. PCL-C = PTSD Checklist-Civilian Version. Model sources: 4a = King et al. (1998); 4b = Simms et al. (2002).
* $p < .05$. ** $p < .01$. *** $p < .001$.

perhaps because only 3 of the 17 items loading on different factors across the two models. The very slight superiority of the King et al. model on most fit indices is consistent with a growing body of research comparing models of PTSD symptom structure in various populations (McWilliams et al., 2005; Palmieri & Fitzgerald, 2005; Schinka et al., 2007), including combat veterans (King et al., 1998). Our study extends the generalizability of this structure by including the first large, population-based military sample.

We examined the degree of measurement invariance exhibited by the PCL-C across deployment subgroups of active duty military personnel. To capture symptoms not exclusively due to military service, or those resulting from premilitary or precombat stressors (e.g., sexual and physical abuse), military researchers and the DoD have preferred the PCL-C over the PCL-M (e.g., Bray et al., 2006; Lang, Laffaye, Satz, Dresselhaus, & Stein, 2003; National Center for PTSD, 2004). However, our findings suggest that military experiences, such as those associated with deployment to combat theaters, may introduce nonequivalence of measurement by the PCL-C. Similar to Simms et al.'s (2002) findings, metric (and configural) invariance was found for both 4-factor models, suggesting that symptoms covaried and related to the same factors across deployment subgroups. In contrast, the lack of scalar invariance for all factors across both models indicates that the observed PCL-C responses cannot be wholly accounted for by variation in the latent factor means of each group—respondents with the same factor mean but in different groups (deployed vs. nondeployed) will have different observed values despite identical levels of the underlying construct. Failure to achieve scalar invariance complicates substantive analysis models that wish to include these latent factors because covariate effects on factor means are confounded by this lack of invariance. In such cases, comparisons of deployed and nondeployed factor means are not interpretable, and

covariate effects on PCL means where the covariate is knowingly or unknowingly related to deployment status (e.g., some types of trauma exposure) are also confounded. Similarly, the impact of PCL means on other mental health variables is distorted when invariance does not hold. Identifying the cause of measurement invariance is difficult in cases where there is little intuition as to why item performance varies across typical groups, such as gender or race/ethnicity (Schmitt & Kuljanin, 2008). This is largely true for our findings, as it is not readily apparent what aspects of deployment experiences and possible combat exposure may cause personnel to respond to PCL-C symptoms at levels that are not equivalent to their nondeployed counterparts given they share underlying factor scores. Our study cannot explain these differences, but highlights the need to further investigate the measurement properties of the PCL-C if it is to be administered to military personnel with varying deployment histories.

Although weighted to represent the active duty force during the study period, our sample excludes certain groups who, despite being relatively smaller in numbers (i.e., recruits, academy students, AWOL) or likely very similar to our sample demographically (i.e., PCS), could not be accounted for in the weighting process. Despite these exclusions, the sample and findings are pertinent to active duty military personnel most likely to be affected by PTSD at present—those returning from deployment to Iraq and Afghanistan. Another sample-related limitation is the lack of deployment data for 313 respondents. Without this grouping variable, these cases could not be used to evaluate the measurement invariance for both 4-factor models. Although personnel with unknown deployment histories reported elevated PCL-C means, it is unlikely that their omission influenced invariance testing in light of scalar variance for each subfactor of both 4-factor models. Finally, the lower response rate (∼52%) may reflect our inability to offer incentives for participation, yet its effects on our results should be mitigated by the weighting/poststratifying of sample data to represent active duty personnel overall.

Although a general lack of scalar invariance was found, the statistical and practical significance of this finding is not unequivocal. Two primary issues temper this conclusion. First, given the ratio of sampling units (clusters) to the number of parameters needed for invariance testing, it was not possible to utilize the sampling structure to adjust the variances of estimates in each group. This generally has the effect of attenuating standard errors in comparison to their true values and artificially magnifying the difference between nested models using the likelihood ratio test (Asparouhov, 2005). However, because the metric invariance tests were nonsignificant, they were apparently not greatly influenced by this lack of precision in the variance estimates, thus the lack of variance correction cannot entirely explain the lack of scalar invariance across deployment subgroups. Secondly, the impact of sample size on χ^2 and the $\Delta\chi^2$ test in MCFA is well known (Brannick, 1995; Kelloway, 1995), meaning the lack of scalar invariance detected in these analyses may be a function of large sample size rather than real differences in measurement. When the change in CFI test (Δ_{CFI}) was used, proposed by Cheung and Rensvold (2002) as an alternative criterion for invariance testing, no difference in intercepts was found for either the full Model 4a or the individual factors. Thus, the Δ_{CFI} test suggested no real difference in measurement based upon deployment status during the previous year. However, support for the Δ_{CFI} test as a method for evaluating measurement invariance is not uniform. Follow-up simulations (French & Finch, 2006) found the test to perform more erratically than $\Delta\chi^2$ and supported the use of $\Delta\chi^2$ even in large samples. Further investigation of the PCL-C factors in relation to other constructs is needed to estimate if the intercept differences suggested in this study have a substantive or statistical impact on other models of interest.

Using a population-based sample of active duty military personnel has provided a unique opportunity to assess the underlying structure of PTSD symptoms in individuals with a wide variety and amount of traumatic exposure. The increasing number of U.S. military personnel returning from duty in Iraq and Afghanistan with symptoms of PTSD highlights the importance of effectively identifying individuals experiencing symptoms. This analysis adds to existing research showing that, although the PCL-C's 17 items are written to directly correspond to the *DSM-IV* B, C, and D symptom criteria used in the diagnosis of PTSD, a 4-factor grouping may better represent PTSD symptomatology in this population and possibly in others. Which 4-factor model is best is still uncertain, but our results help clarify the measurement properties of the PCL-C. Despite a general reliance on the PCL-C by the U.S military, there appear to be significant differences in the level of observed responses between personnel who were recently deployed and those who were not. These differences exceed what would be expected for individuals with similar PCL latent factors scores, yet the exact source of this nonequivalence is unknown. Still, results presented here provide a cautionary message about comparing PCL factors across groups or using these factors in other structural models without first examining the degree of measurement invariance present. What remains quite limited and needed in future studies is a continued focus on testing the robustness of the best-fitting model across a set of relevant subgroups.

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APPENDIX 2

Post-Deployment alcohol use, aggression, and posttraumatic stress disorder.

Post-Deployment Alcohol Use, Aggression, and Posttraumatic Stress Disorder

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Abstract

Background: The wars in Iraq and Afghanistan are producing a generation of military personnel who are at risk of developing serious mental health problems, including chronic stress disorders and substance use disorders. The most frequently studied effect of combat exposure is posttraumatic stress disorder (PTSD). High-risk behaviors, including increased alcohol use and verbal and physical aggression, have been associated with PTSD, but the optimal cutoff score on the PTSD Checklist (PCL) for determining this risk has not been clearly delineated.

Method: Using post-deployment active duty (male = 6,838, female = 1,516) and Reserve component military personnel (male = 5,030, female = 1,044), this study sought to determine the relation between various cutoff scores on the PCL and engaging in high-risk behaviors.

Results: Prevalence rates for alcohol use increased in both samples as PCL scores increased. For active duty personnel, reports of verbal (72%) and physical (19%) aggression were highest when PCL scores were at or above 50. Among Reserve component personnel, verbal aggression (66%) and risk taking/impulsiveness (70%), were highest when PCL scores were between 44 and 49, while the highest incidence of physical aggression (16%) and drug use (31%) were reported when PCL scores were at or above 50.

Conclusions: The differences in findings of problem behaviors for active duty and Reserve component personnel may be an indication that deployment experiences and combat exposure affect these populations differently and suggest that active duty personnel may be at higher risk for developing problems as a result of their combat experiences.

Key Words: Military; Alcohol; Posttraumatic Stress Disorder; Aggression

Introduction

The wars in Iraq and Afghanistan are producing a new generation of veterans who are at risk of developing serious mental health problems, including substance use disorders (e.g., alcohol, illicit drugs, prescription drugs) and chronic stress disorders. Based on the most current estimates, about 261,000 American troops are serving in Iraq and Afghanistan (National Association of State Directors of Veterans Affairs, 2009). Studies have shown that the short-term rates of psychiatric and substance use disorders among this group are higher than in the civilian population (Hoge et al., 2004; Hoge et al., 2007; Seal et al., 2007). Combat duty is associated with increased utilization of mental health services and increased attrition from the military (Hoge et al., 2006; Milliken et al., 2007; Seal et al., 2008).

The most frequently studied psychological effect of combat exposure is posttraumatic stress disorder (PTSD), a term for the psychological consequences of exposure to stressful events that an individual experiences as traumatic. Clinically, such events involve actual or threatened death, serious physical injury, or a threat to physical and/or psychological integrity (APA, 2000). It has been estimated that up to 19% of Operation Iraqi Freedom (OIF)/Operation Enduring Freedom (OEF) combat veterans develop PTSD within a year of returning home (Tanielian & Jaycox, 2008). For the remaining personnel, the emotional effects of traumatic events tend to subside after several months (Milliken et al., 2007). The presence of a PTSD response is influenced by the intensity of the experience, its duration, and individual differences (e.g., coping, social support). For those personnel who exhibit symptoms of PTSD, comorbidity with other psychiatric disorders, including substance use disorders, is common (Hoge et al., 2006).

Top levels of military medical commands recently acknowledged that almost all combat veterans experience some degree of combat and operational stress response, including lack of

sleep, irritability, isolation, and other responses, including PTSD (Army Behavioral Health, 2008). Individuals may increase substance use to suppress these symptoms, both as a short-term coping mechanism or as a long-term suppression mechanism (Kessler et al., 1996). Exposure to combat in Iraq and Afghanistan has been linked to high rates of alcohol use on return from deployment, particularly among Soldiers and Marines (Milliken et al., 2007). These higher rates of alcohol use among combat veterans may be due to increased stress reactions in this population.

A number of additional high-risk behaviors have been associated with PTSD, combat exposure, and alcohol use. Begic and Jokic-Begic (2001) found a significantly greater occurrence of aggressive behavior among combat veterans diagnosed with PTSD compared to combat veterans with no PTSD diagnosis. Likewise, others have reported that violent outbursts and aggressive behavior, hostility, and poor anger control are common sequelae of military combat, particularly among those with PTSD (Beckham et al., 1997; Byrne & Riggs, 1996; McFall et al., 1999). PTSD has been shown to be predictive of greater risk-taking propensity, as well as increased alcohol use and verbal and physical aggression toward others (Killgore et al., 2008). Problematic alcohol use has been reported as a risk factor for aggression in both military and civilian populations (Murdoch et al., 1990; Murphy et al., 2001).

Given the associations among substance use, combat exposure and related stress reactions, and PTSD, and the findings that the majority of combat veterans do not develop full-blown PTSD, a less strict criterion for assessing stress responses that includes less severe but practically meaningful symptoms is useful because substance abuse may be used to control these stress reactions. A remaining issue is the determination of the presence of PTSD symptomatology. If these high-risk behaviors are indeed linked to PTSD and other stress

reactions, it becomes essential to accurately screen for the presence of PTSD symptomatology. To address this issue, a measure of PTSD symptoms is needed that will allow us to relate risk behaviors to the severity of PTSD symptoms. One such measure widely used in scientific surveys is the PTSD Checklist (PCL). The PCL is a self-report measure of the 17 DSM-IV symptoms of PTSD and was first presented by Weathers and colleagues in 1993 (Weathers et al., 1993). Items are rated on a 5-point scale ranging from 1 ("not at all") to 5 ("extremely") with a suggested cumulative cutoff score of 50 as a clinically useful score suggestive of the need for further evaluation for PTSD. More recent studies have indicated that an optimal score for identifying PTSD in various populations may be somewhat lower, ranging from 30–34 (Bliese et al., 2008; Yeager et al., 2007) to 44 (Terhakopian et al., 2008), but there are no clear guidelines to help users distinguish between the cutoffs recommended in these studies.

With such a wide range of cutoff scores being documented as relevant for the accurate screening for PTSD, the question arises as to how the various cutoff scores relate to risk for other types of problematic behaviors. Using active duty and Guard/Reserve personnel, our study examines the relations among various PCL cutoff scores and engaging in a number of high-risk behaviors, including alcohol and drug use, physical and verbal aggression, and risk taking/impulsiveness.

Method

Participants

Participants in this study comprised active duty (AD), and Reserve component (RC) military personnel randomly selected to complete a self-report survey as part of two large studies. The Department of Defense (DoD) Survey of Health Related Behaviors Among Active Duty Military Personnel (HRB survey) is a population-based study conducted periodically

among U.S. military personnel stationed worldwide to assess a variety of health behaviors. The 2005 HRB survey included items to assess alcohol and tobacco use, drug use, mental health, risk taking and impulsive behavior, and deployment, among other areas of functioning. The eligible population for the 2005 HRB survey consisted of all U.S. active duty military personnel except recruits, service academy students, personnel absent without official leave (AWOL), and personnel who had a permanent change of station (PCS) at the time of data collection. Participants were selected to represent men and women in all pay grades of the active forces throughout the world. The final sample consisted of 16,146 military personnel (3,639 Army, 4,627 Navy, 3,356 Marine Corps, and 4,524 Air Force) who completed self-administered questionnaires anonymously for a response rate of 51.8%. Data were weighted to reflect respondents' probabilities of selection and adjusted to account for the potential effects of nonresponse. Additional details on HRB survey methodology may be found elsewhere (Bray et al., 2006). Military population statistics provided by the Defense Manpower Data Center (DMDC) were used to post-stratify the sample data to represent the target population.

The 2006 RC survey was conducted among U.S. military personnel stationed in all 50 states. The target population included all nonactivated military Reserve and Guard personnel at the time of data collection, April through September 2006. Personnel came from six Reserve components—Army Reserve, Army National Guard, Navy Reserve, Marine Corps Reserve, Air Force Reserve, and Air National Guard. The 2006 RC questionnaire was nearly identical to the questionnaire used for the 2005 HRB survey and included questions assessing alcohol and tobacco use, drug use, mental health, risk taking, and impulsive behavior. Data were collected primarily from participants in group settings at military installations; they were obtained by mail for those not attending the sessions. The final RC sample consisted of 15,212 completed surveys

(2,268 Army National Guard, 1,467 Army Reserve, 3,104 Navy Reserve, 1,867 Air National Guard, 5,409 Air Force Reserve, and 1,097 Marine Corps Reserve). The overall response rate was 55.3%, and data were weighted to represent all RC personnel. The analysis sample for this study consisted of all AD and RC personnel with PCL scores who had deployed within the past 2 years (n = 14,428; AD = 8,354, RC = 6,074).

Measures

The HRB and RC surveys examined alcohol use and several measures of alcohol-related problems, including possible alcohol dependence, drinking and driving, verbal and physical aggression, impulsiveness, and other risky behaviors. They also included the PTSD Checklist–Civilian version (PCL-C).

PTSD symptoms. The PCL-C (Weathers et al., 1994) is a 17-item self-report assessment corresponding to symptom Criteria B, C, and D for PTSD in the DSM-IV and is scored by summing individual item responses to obtain a total score. Scores on the PCL-C range from 17 to 85, with higher scores indicating greater symptom severity. The PCL-C has been found to be highly correlated (r = .93) with a structured interview for PTSD, has good diagnostic efficiency (>.70), and robust psychometric properties with a variety of trauma populations (Blanchard et al., 1996; Ruggiero et al., 2003; Weathers et al., 1993). Given the support for various score cutoffs (Bliese et al., 2008; Terhakopian et al., 2008; Yeager et al., 2007), four groups were formed from the scores on the PCL (PCL 17–29, PCL 30–43, PCL 44–49, PCL $\geq$ 50). Although there is a military version of the PCL (PCL-M), the HRB surveys (and other DoD studies) use the civilian version for several reasons. The PCL-M asks respondents to consider symptoms of PTSD specifically related to military experiences (Weathers et al., 1993), whereas the PCL-C evaluates symptoms resulting from any past traumatic event, not only those attributable to military service.

Assessment of PTSD symptoms from both military and nonmilitary sources is important when considering the overall mental health and readiness of military personnel (National Center for PTSD, 2004). Also, the military version misses common causes of deployment or war-related PTSD in women (e.g., sexual assault rather than combat per se), and deployment-related exacerbations of PTSD symptoms if the original inciting trauma is not military related.

Alcohol use. Alcohol use was assessed with three measures of use over the past 30 days: any alcohol use, heavy alcohol use, and heavy episodic drinking. Heavy drinking was classified as the consumption of five or more drinks per typical drinking occasion at least once per week over the past 30 days. Heavy episodic drinking was defined as consumption of five or more drinks (four for women) on a single occasion at least once in the past 30 days.

Problematic alcohol use. This measure used the Alcohol Use Disorders Identification Test (AUDIT; Babor et al., 2001), which was developed by the World Health Organization (WHO) as a simple method of screening for excessive drinking and of assisting in brief assessment. The AUDIT consists of 10 questions, each scored 0 to 4, which are summed to yield a total score ranging from 0 to 40.

Driving after drinking. Respondents were asked how often they had driven a car or other motor vehicle within 2 hours of drinking any amount of beer, wine, or liquor. Responses were coded as a dichotomous variable classifying persons into those who did and did not drive after drinking.

Physical aggression. Respondents were asked two questions about two types of physical aggression—hitting a spouse, live-in fiancé, boyfriend, or girlfriend, and getting into fights and hitting someone other than a family member during the past 12 months. A positive response to either question classified persons into the physical aggression category.

Verbal aggression. Two questions assessed verbal aggression with a positive response to either question classifying respondents into this category. Questions involved having heated arguments with family or friends or getting into a loud argument in public in the past 12 months.

Risk taking/impulsiveness. Personnel were asked a series of nine questions about their tendency to take risks or act impulsively (e.g., "I often act on the spur of the moment without stopping to think," "I like to test myself every now and then by doing something a little chancy," and "You might say I act impulsively"). Responses were based on a four-point Likert score ranging from 0 (Not at All) to 4 (Quite a Lot). Personnel were determined to be risk taking/impulsive if they responded with "Some" or "Quite a Lot" to six of the nine items.

Drug use. Illicit drug use was measured in terms of the prevalence of nonmedical use of any of nine categories of drugs: (1) marijuana or hashish, (2) cocaine (including crack), (3) hallucinogens/PCP/LSD, (4) amphetamines/stimulants, (5) tranquilizers or other depressants, (6) barbiturates/sedatives, (7) heroin or other opiates, (8) analgesics and other narcotics, and (9) inhalants. Nonmedical use was defined as any use of these drugs either without a doctor's prescription or in greater amounts or more often than prescribed, or for any reasons other than as prescribed, such as for the feelings they caused. Responses were coded as a dichotomous variable classifying persons into those who did and those who did not use illicit drugs over the past year depending on whether they reported the use of at least one illicit drug.

Statistical Analyses

Analyses consisted of calculating population prevalence estimates and analysis of variance (ANOVA) comparisons. Prevalence data were computed for alcohol use (any alcohol use, heavy alcohol use, heavy episodic drinking) and alcohol-related problems (driving after drinking and AUDIT) for military women and men in both the AD and RC populations. Multiple

predictor logistic regression analyses were used to compute odds ratios and were adjusted to control for the effects of demographic differences. Demographic variables included age, pay grade, education, family status, and race/ethnicity. All analyses were weighted to reflect the original sampling design, to adjust for unequal selection probabilities, and to adjust for nonresponse bias. SUDAAN software (Research Triangle Institute, 2002) was used to take into account the survey's complex sampling design and yield accurate standard errors.

Results

As shown in Table 1, in both the AD and RC populations, the majority of personnel were male, white, non-Hispanic, married, had some college education, and were in pay grades E4–E6. RC personnel were older, with the largest proportion being between 25 and 44 years of age, compared to AD personnel, the largest proportion of whom were between the ages 18 and 34. In both samples, 75% of personnel acknowledged scores between 17 and 29 on the PCL, while 9% of RC and 7% of AD personnel had scores in the highest range (i.e., $\geq$50).

[Insert Table 1 about here]

Table 2 reports on alcohol use across the AD and RC populations and the relation of alcohol use to PCL scores. Overall, more than 75% of both populations showed any alcohol use. AD personnel, however, reported significantly higher levels of heavy alcohol use (OR = 1.54, CI = 1.22–1.94) and heavy episodic drinking (OR = 1.53, CI = 1.20–1.94) than their counterparts in the RC (20% vs. 14%; 48% vs. 38%, respectively). AD personnel also had significantly higher AUDIT scores (b = 1.99, $t_{(1, 77)} = 3.86$, $p < .001$) compared to RC personnel.

[Insert Table 2 about here]

Prevalence rates for alcohol use increased in both populations as PCL scores increased, with the largest proportion of individuals reporting increased alcohol use when PCL scores were

at or above 44. Among those with PCL scores in the range of 17 to 29, any alcohol use in the past 30 days was reported by 77% of AD personnel and 74% of RC personnel, while in comparison, for those with PCL scores at or above 50, past 30 days alcohol use was reported by 85% and 86%, respectively. For AD personnel, past month heavy episodic drinking was reported by 44% of those with PCL scores between 17 and 29, and by 66% of those with scores at or above 50. For RC personnel, 35% of those with PCL scores in the 17 to 29 range reported heavy episodic drinking, while the largest percentage (50%) reported heavy episodic drinking when PCL scores were between 44 and 49.

In both populations, a somewhat lower cutoff score on the PCL was associated with the largest percentage reporting driving after drinking. For both AD and RC personnel, driving after drinking was two to three times higher for those with PCL scores in the 44 to 49 range compared to the reference group of those with PCL scores in the 17 to 29 range. Finally, AUDIT scores were significantly higher in both populations when PCL scores were at or above 44.

Table 3 presents additional high-risk behaviors with results indicating similar findings to those for alcohol use behaviors. Overall, AD personnel reported significantly higher levels of verbal aggression (OR = 1.27, CI = 1.11–1.44) and impulsivity (OR = 1.35, CI = 1.12–1.63) than RC personnel. For AD personnel, reports of both verbal (72%) and physical (19%) aggression were highest among those with PCL scores at or above 50. Similarly, acknowledgement of risk taking/impulsiveness was highest among AD personnel with the greatest PTSD symptomatology (73%). In contrast, reports of drug use for AD personnel were highest (46%) among those with PCL scores between 44 and 49.

Among RC personnel, verbal aggression (66%) and risk taking/impulsiveness (70%), were highest for those with PCL scores between 44 and 49. Physical aggression (16%) and drug use (31%) were reported most frequently by individuals who had PCL scores at or above 50.

[Insert Table 3 about here]

Tables 2 and 3 also indicate the results of all pairwise comparisons of each alcohol-related behavior at each level of PCL response grouping. A clear pattern of differences emerged for AD personnel. Each behavior was significantly more likely for response groups with PCL scores higher than 17–29, indicating that PCL scores higher than 29 were associated with enhanced risk. Differences between the upper three categories of PCL response did not show uniform differences. This pattern also held for RC personnel, except for any alcohol use and heavy use. Both of these behaviors were significantly more prevalent only when PCL scores were 50 or higher.

Discussion

The current study examined associations among PTSD symptom reports, alcohol problems, and high-risk behaviors for AD and RC personnel. To maximize the likelihood of finding PTSD symptoms, participants were subsetted to persons who had been deployed during the past 2 years. The findings revealed a positive association in both AD and RC populations among PCL scores and alcohol use, aggressive behaviors, drug use, and risk taking/impulsiveness. Those with lower PCL scores were more likely to have lower problem behavior scores, and those with higher PCL scores were more likely to have higher problem behavior scores. For example, 20% of AD personnel with PCL scores in the 17 to 29 range engaged in heavy alcohol use compared to 31% of AD personnel with PCL scores 50 or higher. This suggests that personnel with more PTSD symptoms may engage in problem behaviors to try

to suppress or cope with their symptoms. The findings are consistent with prior research on this issue for substance use (Kessler et al., 1996).

The most notable finding of this study is that it was not necessary for personnel to have PTSD symptoms (i.e., PCL scores) in the clinically diagnostic range (50 or higher) to be at higher risk for substance use or other problems. This was especially true for AD personnel who, for every outcome examined, showed significantly greater odds for each problem behavior when PCL scores were 30 or higher compared to those with PCL scores in the 17 to 29 range. A similar pattern was shown for RC personnel with respect to several problem behaviors, although not for alcohol use behaviors. For RC personnel, only those with PCL scores of 50 or higher had greater odds of reporting any alcohol use, heavy alcohol use, and heavy episodic drinking. These findings suggest that personnel with PCL scores higher than 50 are likely to have additional problems, including increased alcohol use, aggression, and risky or impulsive behaviors. Thus, even for those who do not exhibit strong PTSD symptomatology, screening for other high risk behaviors should be conducted. Reducing the PTSD criterion score for recognizing potential stress reactions may lead to the identification of a larger percentage of personnel who need additional care in dealing with combat stress.

The differences in findings of problem behaviors for AD and RC personnel may be an indication that deployment experiences and combat exposure affect AD and RC populations differently and suggest that AD personnel may be at higher risk for developing problems as a result of their combat experiences. At first these results may appear counterintuitive in that AD personnel, as a function their active duty status, appear to have stronger support systems in place than RC personnel in terms of continuing family and unit programs, and physical and mental health care. However, AD personnel may have greater concerns about stigma issues if they seek

needed services to help them cope with their stressors. It is easier for RC personnel, upon return to their civilian jobs, to obtain civilian care that will be covered by insurance than for AD personnel to seek similar care. It may be cost prohibitive for AD persons to go outside the system and pay for their own mental health care needs.

There are limitations to the current study. First, the restricted item content for physical and verbal aggression is a limitation of the study. Evidence from some military studies suggests that direct versus indirect forms of aggression correlate differently with PTSD, while other studies have found an increase in intimate partner violence among those with PTSD symptomatology (Archer, 2004; Taft et al., 2005). There is also evidence among civilian studies suggesting that the hyperarousal symptom cluster in PTSD may lead to reactive aggression and impulsive behavior (Novaco and Chemtob, 1998; Patterson and Newman, 1993). Clearly, research that examines a more detailed assessment of different forms of aggression, an analysis of whether aggression was directed toward a partner or others, and the relations between specific symptom clusters and behavior is warranted.

Second, our data are cross-sectional and do not allow us to make causal inferences. Thus, we are not able to isolate whether a greater number of PTSD symptoms leads to more stress reactions or whether post-deployment personnel may use alcohol and/or other drugs as a way of coping with stress.

The current study highlights the need to better understand the relations among PTSD symptoms, alcohol use, and aggression in order to develop interventions aimed at reducing both the health and interpersonal consequences associated with post-deployment functioning. Results suggest that negative behaviors increase as symptomatology increases and point to the potential

value of the early treatment of stress symptoms to reduce the likelihood of engaging in high-risk behaviors by military personnel.

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Table 1. Characteristics of Study Participants

	Reserve Component (N = 6,074)	Active Duty (N = 8,354)
Sociodemographic Characteristic	**N (%)**	**N (%)**
Gender		
Male	5,030 (86.5)	6,838 (89.2)
Female	1,044 (13.5)	1,516 (10.8)
Race/Ethnicity		
White, non-Hispanic	3,841 (72.6)	5,228 (66.1)
African American, non-Hispanic	681 (13.2)	1,264 (16.6)
Hispanic	634 (7.9)	1,050 (8.9)
Other, non-Hispanic	766 (6.3)	812 (8.4)
Education		
High school or less	933 (22.0)	2,267 (33.9)
Some college	3,021 (44.8)	3,653 (45.1)
College graduate or higher	2,120 (33.2)	2,434 (21.5)
Age		
18-24	706 (14.8)	2,240 (36.0)
25–34	1,650 (31.3)	2,814 (39.7)
35–44	2,382 (33.5)	2,807 (21.4)
45 or older	1,336 (20.3)	493 (3.0)

Sociodemographic Characteristic	Reserve Component (N = 6,074) N (%)	Active Duty (N = 8,354) N (%)
Marital Status		
Not married	1,971 (33.1)	2,660 (38.0)
Married	4,056 (66.9)	5,682 (62.0)
Pay Grade		
E1–E3	131 (2.6)	915 (16.1)
E4–E6	3,626 (62.0)	3,503 (56.2)
E7–E9	1,253 (15.5)	1,764 (10.7)
W1–W5	40 (1.59)	278 (1.5)
O1–O3	268 (6.2)	883 (9.5)
O4–O10	756 (11.6)	1,011 (6.0)
PCL Category		
17–29	4,844 (74.5)	6,469 (75.3)
30–43	791 (14.3)	1,165 (14.3)
44–49	131 (2.4)	218 (3.4)
≥ 50	308 (8.8)	502 (7.0)

Note: Percentages are weighted estimates

Table 2. Percentage of Active Duty and Reserve Component Personnel Engaging in Alcohol Use Behaviors in the past 30 days by PCL Score

	Any Alcohol Use		Heavy Alcohol Use		Heavy Episodic Drinking		Drink and Drive		Mean AUDIT Score	
Active Duty	**%**	**OR**	**%**	**OR**	**%**	**OR**	**%**	**OR**	**%**	**OR**
Overall	78.88		19.87		47.96		14.43		5.4	
PCL 17–29	77.41[a]	ref	17.39[a]	ref	43.91[a]	ref	11.93[a]	ref	4.6[a]	ref
PCL 30–43	82.01[b]	1.4[*]	25.49[b]	1.4[*]	56.83[b]	1.5[*]	18.98[b]	1.6[*]	6.7[b]	1.7[*]
PCL 44–49	85.94[b]	1.7	30.16[b]	1.4	62.75[bc]	1.6	32.09[c]	2.9[c]	8.7[c]	3.1[*]
PCL $\geq$ 50	84.85[b]	1.6[*]	31.18[b]	1.5[*]	65.95[c]	1.9[*]	23.54[bc]	1.9[*]	9.3[c]	3.6[*]
Reserve Component										
Overall	75.25		13.67[1]		37.54[1]		14.28		4.1[1]	
PCL 17–29	73.90[a]	ref	12.02[a]	ref	34.75[a]	ref	11.97[a]	ref	3.5[a]	ref
PCL 30–43	74.56[a]	1.0	16.43[ab]	1.3	44.32[b]	1.2	23.97[b]	2.0[*]	5.3[b]	1.5[*]
PCL 44–49	81.39[ab]	1.5	22.67[ab]	2.4	50.08[ab]	1.9	26.40[b]	2.4[*]	7.3[b]	3.8*

PCL $\geq$ 50	86.21[b]	1.8[*]	21.20[b]	2.0[*]	46.86[ab]	1.9[*]	14.64[a]	1.2	6.0[b]	2.6[*]

NOTE: Estimates not sharing a common superscript differ at $p<.05$.

[*]: Significant at $p<.05$.

[1]: Overall estimate for RC differs from overall AD estimate at $p<.05$.

Percentages shown are unadjusted estimates. Odds ratios are derived from logistic regression models and adjust for age, gender, race/ethnicity, education, marital status, and pay grade.

Table 3. Percentage of Active Duty and Reserve Component Personnel Engaging in Other Risk Behaviors by PCL Score

	Verbal Aggression		Physical Aggression		Impulsiveness		Drug Use	
Active Duty	**%**	**OR**	**%**	**OR**	**%**	**OR**	**%**	**OR**
Overall	48.16		7.44		40.87		17.32	
PCL 17–29	42.18[a]	ref	5.47[a]	ref	34.3[a]	ref	12.47[a]	ref
PCL 30–43	63.69[b]	2.5[*]	10.64[b]	1.8[*]	53.81[b]	2.0[*]	28.12[b]	2.4[*]
PCL 44–49	66.16[bc]	2.8[*]	13.34[bc]	1.8[*]	65.28[c]	2.8[*]	45.68[c]	4.5[*]
PCL $\geq$ 50	71.94[c]	3.6[*]	19.33[c]	2.8[*]	73.21[c]	4.2[*]	36.23[bc]	2.8[*]
Reserve Component								
Overall	42.29[1]		6.82		34.21[1]		16.92	
PCL 17–29	36.60[a]	ref	4.69[a]	ref	27.59[a]	ref	12.56[a]	ref
PCL 30–43	59.54[b]	2.4[*]	11.73[b]	2.3[*]	53.77[b]	3.0 [*]	28.56[b]	2.6[*]
PCL 44–49	65.80[b]	3.6[*]	11.84[ab]	2.7[*]	69.93[c]	8.0[*]	30.41[b]	2.9[*]
PCL $\geq$ 50	56.02[ab]	3.2[*]	15.53[b]	3.4[*]	49.02[bc]	3.3[*]	31.40[b]	4.0[*]

NOTE: Estimates not sharing a common superscript differ at $p<.05$.

[*]: Significant at $p<.05$.

[1]: Overall estimate for RC differs from overall AD estimate at $p<.05$.

Percentages shown are unadjusted estimates. Odds ratios are derived from logistic regression models and adjust for age, gender, race/ethnicity, education, marital status, and pay grade.

APPENDIX 3

Prevalence of Perceived Stress and Mental Health Indicators among Reserve Component and Active Duty Military Personnel.

Prevalence of Perceived Stress and Mental Health Indicators Among Reserve-Component and Active-Duty Military Personnel

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Objectives. We examined stress levels and other indicators of mental health in reservists and active-duty military personnel by deployment status.

Methods. We used data from the Department of Defense Health-Related Behaviors surveys, which collect comprehensive, population-based data for reserve and active-duty forces. Data were collected from 18 342 reservists and 16 146 active-duty personnel.

Results. Overall, with adjustment for sociodemographic and service differences, reservists reported similar or less work and family stress, depression, and anxiety symptoms than did active-duty personnel. However, reservists who had been deployed reported higher rates of suicidal ideation and attempts than did active-duty personnel who had been deployed and higher rates of post-traumatic stress disorder symptomatology than did any active-duty personnel and reservists who had not been deployed. The highest rates of suicidal ideation and attempts were among reservists who had served in theaters other than Iraq and Afghanistan.

Conclusions. Our results suggest that deployment has a greater impact on reservists than on active-duty members, thus highlighting the urgent need for services addressing reservists' unique postdeployment mental health issues. Also, deployment to any theater, not only Iraq or Afghanistan, represents unique threats to all service members' mental well-being. (*Am J Public Health.* Published online ahead of print January 19, 2012: e1–e8. doi:10.2105/AJPH.2011.300280)

The US military reserve component, which includes both Reserve and National Guard personnel, provides trained units and qualified persons for active-duty service in time of war or national emergency. Reserve-component personnel may be called to active-duty status to supplement the active-duty component during such times. National Guard units also provide personnel in response to state emergencies. As of July 2008, the total strength of the US military reserve component was 1.1 million, with approximately 10% serving with the active-duty component.[1] Once activated, reserve-component service members proceed through the same deployment stages and processes as do active-duty forces. However, they face additional challenges associated with being "citizen Soldiers," such as arranging extended leaves of absence with civilian employers, planning for reintegration upon their return, and making arrangements for their families. Furthermore, the uncertainty that often accompanies activation and deactivation and the organizational constraints, such as lack of equipment and training readiness, have been associated with their psychological well-being.[2]

Milliken et al.[3] found, on the basis of Post-Deployment Health Assessment and Post-Deployment Health Re-Assessment interviews, that more than twice as many reserve-component as active-duty service members returning from Operation Iraqi Freedom (OIF) reported symptoms sufficient to require mental health treatment (42.4% vs 20.3%, respectively). Although important, their study was limited to a sample of recently returning service members who may not be representative of the broader active-duty and reserve-component populations and thus may not provide an accurate picture of the relative mental health needs between and within components of the total force. Therefore, a need exists for population-based data comparing the mental health needs of active-duty and reserve-component personnel.

Drawing on 2 comprehensive surveys, we helped to fill this data gap by providing the first population-based assessment and comparison of reserve-component and active-duty mental health on the basis of selected indicators during the OIF and Operation Enduring Freedom (OEF) conflicts. This work augments existing research[2] by examining specific mental health issues encountered by reservists, as suggested by Milliken et al.,[3] rather than a global but somewhat vague construct of psychological well-being.

METHODS

All data were drawn from 2 US Department of Defense Surveys of Health-Related Behaviors (HRB): the 2006 reserve-component[4] and the 2005 active-duty[5] surveys. Although a series of active-duty surveys have been conducted over the years, the 2006 reserve-component survey is the first survey conducted for the reserve component. As the only large-scale, representative, population-based surveys of the total force (excluding the Coast Guard), the HRB Surveys generate the most comprehensive data on both the reserve-component and active-duty forces. Although the Post-Deployment Health Assessment and Post-Deployment Health Re-Assessment include brief screenings for physical and mental health concerns, such as alcohol use and post-traumatic stress disorder (PTSD), the HRB Surveys cover a much broader array of topics with greater depth. Institutional review board approval was granted through both RTI International and Department of Defense review boards, and the surveys were deemed to be of minimal risk.

The sample sizes for the 2006 reserve-component and the 2005 active-duty surveys were 18 342 (55.3% response rate) and

16 146 (51.8% response rate), respectively. Both surveys were self-administered via anonymous, paper questionnaires. Participants were selected to represent men and women in all pay grades of the active-duty and reserve-component forces worldwide who were not absent without leave, incarcerated, recruits, or undergoing a permanent change of station. Data were collected primarily from participants in group sessions at military installations (90%) and were obtained by mail for those not attending group sessions (10%).

We compared estimates of mental health indicators for active-duty personnel with estimates for 2 reserve-component groups: (1) Active Guard/Reserve Program participants or full-time National Guard reservists, hereafter referred to as "full-time reservists," and (2) all others, hereafter referred to as "traditional reservists." Full-time reservists differ from traditional reservists in that they serve full time, have many of the same privileges (including medical benefits) as active-duty personnel, and serve primarily as direct support to traditional reservists.[6] Traditional reservists, by contrast, typically participate in one weekend per month of training and attend a 2-week training session once yearly, except during activation or deployment cycles.

Measures

Questionnaires for the active-duty and reserve-component surveys used the same or similar items for all constructs. In addition to demographic items, surveys included questions assessing stress, mental health, and deployment-related issues.

Stress. Respondents were asked to indicate the level of stress they attributed to their military work, to intimate and family relationships, and, for women, to being a woman in the military, and to provide information on the perceived impact of stress on their military performance. Respondents who reported experiencing "a lot" (work and family) or "a great deal/a fairly large amount" (being a woman in the military) of stress were categorized as having high stress related to these factors, respectively.

Anxiety. To screen for generalized anxiety disorder (GAD) symptoms, the surveys used a set of items adapted from the Patient Health Questionnaire.[7] If respondents reported feeling nervous, anxious, or "on edge" or that they had been worrying about different issues (the first questions in the set) for several days, other symptoms were examined. Respondents who also reported experiencing 3 or more symptoms on more than half of the past 30 days were considered to have met the screening criteria for GAD.

Depression. Need for further depression evaluation was assessed by using the 3-item Version A Burnam depression screen.[8] Personnel were defined as needing further evaluation or assessment if they (1) felt sad, blue, or depressed for 2 weeks or more in the past 12 months or (2) reported 2 or more years in their lifetime of feeling depressed and felt depressed "much of the time" in the past 12 months and (3) felt depressed on 1 or more days in the past week. This scale has shown high sensitivity and good positive predictive value for detecting depressive disorder.[9]

Post-traumatic stress disorder. The PTSD Checklist-Civilian Version (PCL-C)[10] was used to screen for PTSD and included 17 questions asking about the symptoms of PTSD according to the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR)*.[11] The civilian rather than the military version (PCL-M) was used to capture PTSD symptoms that may be the result of nonmilitary experiences (e.g., traumatic exposures occurring before being in the National Guard/Reserve).[12] Items include characteristics such as loss of interest in activities the respondent used to enjoy and having physical reactions when reminded of a stressful experience. Respondents indicated how much they have been bothered by each of the 17 symptoms with items scored from 0 ("not at all") to 4 ("extremely"). Items were summed to obtain a total score, with scores greater than or equal to 50 indicating a positive screen for PTSD.[13]

Suicidal ideation and suicide attempts. Suicidal ideation and suicide attempts were assessed by asking respondents about the occurrence of suicidal thoughts and suicide attempts within the past year and relative to joining the military.

Operational theater and frequency of deployment. Items regarding theater and frequency of deployment (during the 36 months preceding survey administration) were included to assess the impact of deployment on mental health outcomes. Three groups were defined for operational theater: (1) those who had served in either Iraq or Afghanistan (OIF or OEF); (2) those who had served in other operational theaters besides OIF or OEF such as the Gulf War, Somalia, and the like; and (3) those who had not been deployed to an operational theater. Deployment frequency contrasted those who had never been deployed with those who had been deployed 1 or more times in the past 3 years.

Statistical Analyses

We conducted our analyses with SAS version 9.1 (SAS Institute Inc, Cary, NC) and SUDAAN version 9.0 (Research Triangle Institute, Research Triangle Park, NC). Initial sample weights were constructed by using probability of selection at each stage of the study design. Variables used in the sampling included service or reserve component, location (within the continental United States or outside the continental United States), gender, and pay grade. These weights were adjusted for survey eligibility and nonresponse after data collection was completed. The weights were also poststratified and included age, race, and ethnicity. Data were standardized to service or reserve component, gender, age, pay grade (enlisted or officer), marital status, education, and race/ethnicity distributions for the total reserve and active-duty components, respectively, by using the predicted marginals approach.[14] Significance testing between groups was conducted by using the *t* test. Analyses were conducted by deployment status and theater by using standardized data to control for demographic differences between those who had been deployed and those who had not and between those who served in different operational theaters.

RESULTS

The sociodemographic characteristics of the reservists and active-duty personnel are presented in Table 1. Overall, the groups were similar with regard to gender and race/ethnicity; all groups were mainly male and non-Hispanic white. Reservists were more likely to have higher levels of education than did active-duty personnel and were older on average than were active-duty personnel. Significantly more full-time reservists and active-duty

TABLE 1—Sociodemographic Characteristics of the Eligible Participant Population: US Department of Defense Surveys of Health-Related Behaviors, 2006 Reserve Component and 2005 Active Duty Component

Sociodemographic Characteristics	Traditional Reserve Component,[a] % (SE)	Full-Time Reserve Component,[b] % (SE)	Active-Duty Component,[c] % (SE)
Service branch			
Army	42.2 (5.1)	40.8 (8.0)	31.8 (5.0)
Army National Guard	23.2 (4.5)	22.0 (7.1)	
Navy	9.8 (2.2)	1.9 (0.5)	26.8 (3.5)
Marine Corps	5.3 (0.7)	1.6 (0.7)	12.7 (2.2)
Air Force	10.4 (4.3)	25.1 (8.5)	28.7 (3.0)
Air National Guard	9.1 (2.9)	8.7 (2.4)	
Gender			
Male	82.5 (1.6)	82.5 (2.2)	85.2 (0.7)
Female	17.5 (1.6)	17.5 (2.2)	14.8 (0.7)
Race/Ethnicity			
White, non-Hispanic	69.0 (3.5)	69.1 (4.9)	64.4 (1.2)
African American, non-Hispanic	14.4 (1.8)	14.3 (2.8)	17.6 (1.0)
Hispanic	11.0 (1.9)	10.5 (2.0)	8.8 (0.5)
Other	5.6 (1.8)	6.1 (2.5)	9.2 (0.6)
Education			
≤high school	25.8 (2.0)[e,f]	16.0 (2.1)[d,f]	33.9 (1.5)[d,e]
Some college	47.9 (0.9)[d]	47.5 (2.6)	44.1 (1.3)[d]
College graduate or higher	26.2 (1.8)[e]	36.5 (3.4)[d,f]	22.0 (1.7)[e]
Age, y			
≤24	32.0 (2.1)[e,f]	9.2 (1.2)[d,f]	40.9 (1.9)[d,e]
25–34	28.3 (1.0)[d]	27.5 (3.1)[d]	36.0 (1.0)[d,e]
35–44	25.5 (1.1)[e,f]	39.8 (2.1)[d,f]	19.7 (1.1)[d,e]
≥45	14.2 (0.9)[e,f]	23.5 (2.3)[d,f]	3.4 (0.4)[d,e]
Marital status			
Not married, unknown	52.0 (1.9)[e,f]	33.8 (3.5)[d,f]	45.5 (1.4)[d,e]
Married	48.0 (1.9)[e,f]	66.2 (3.5)[d,f]	54.5 (1.4)[d,e]
Pay grade			
E1-E3	19.6 (2.0)[e]	5.0 (1.2)[d,f]	24.0 (1.7)[e]
E4-E6	56.9 (1.9)[e,f]	46.0 (3.9)[d]	49.6 (1.8)[d]
E7-E9	9.9 (0.9)[e]	27.8 (1.8)[d,f]	9.7 (0.8)[e]
W1-W5	1.0 (0.6)	1.7 (1.1)	1.0 (0.1)
01-03	5.6 (0.6)[d]	5.7 (1.2)[d]	9.4 (1.0)[d,e]
04-010	7.0 (0.9)[e]	13.8 (2.9)[d,f]	6.3 (0.8)[e]
Any deployment in past y	18.8 (1.9)[e,f]	24.9 (2.2)[d]	29.9 (2.5)[d]

Note. Table displays the weighted percentage of reservists and active-duty personnel by sociodemographic characteristic. Initial sample weights were derived by using probability of selection at each stage of the study design. Variables used in the sampling included service component, service location (within the continental United States or outside the continental United States), gender, and pay grade. These weights were adjusted for survey eligibility and nonresponse after data collection was completed. The weights were also poststratified and included age, race, and ethnicity. Percentages may not sum to 100 because of rounding.

[a]Unweighted n = 15 212.

[b]Unweighted n = 3130. Full-time reserve component refers to the Active Guard or Reserve Program and full-time National Guard or reservist.

[c]Unweighted n = 16 146.

[d]Estimate is significantly different from the traditional reserve component at the 95% confidence level.

[e]Estimate is significantly different from the full-time reserve component at the 95% confidence level.

[f]Estimate is significantly different from active-duty personnel at the 95% confidence level.

personnel than traditional reservists were married. Across all 3 groups, most personnel were in lower pay grades, that is, E1 to E6. Full-time reservists had the largest percentages of E7-E9 enlisted and senior officers. Full-time reservists were likely to have been deployed at rates similar to active-duty personnel, and both were significantly more likely to have been deployed in the past year than were traditional reservists.

Stress and Mental Health

Because of the demographic differences between reserve-component and active-duty personnel, we adjusted the analyses comparing the groups for gender, race/ethnicity, education, age, marital status, pay grade, and service or reserve component. The adjusted estimates in Table 2 showed that active-duty personnel were significantly more likely to report high stress associated with carrying out military duties than were traditional reservists or full-time reservists; however, high family stress did not differ significantly between traditional reservists, full-time reservists, and active-duty personnel. Women on active duty were significantly more likely than were traditional and full-time reservists to report that they experienced a "great deal" or a "fairly large amount" of stress associated with being a woman in the military.

Active-duty personnel were significantly more likely to need further evaluation for depression than were either of the reserve-component groups and were more likely to have met the screening criteria for GAD symptoms than were the reserve-component groups. Of interest, we found no significant difference between reservists and active-duty personnel in the likelihood of meeting the screening criteria for PTSD when we adjusted for sociodemographic differences.

Stress, Mental Health, and Deployment

Traditional reservists and active-duty personnel are contrasted in Table 3 regarding stress and mental health indicators by deployment status during the past 36 months. Full-time reservists were not included because of their different military roles and functions. Our focus was on the adjusted estimates.

As shown, active-duty personnel reported significantly higher levels of stress while carrying out military duties than did reservists. Active-duty personnel who had been previously deployed were significantly more likely to report high stress while carrying out military duties than were those who had not been deployed, whereas previously deployed reservists reported stress levels similar to those of their nondeployed counterparts. Stress in the family showed a similar pattern to stress at work; however, we found no significant difference in the level of family stress between reservists who had been deployed and active-duty personnel who had been deployed. Reservists showed the same general directional pattern as did active-duty personnel on both stress indicators with regards to deployment, but the differences were smaller and nonsignificant between reservist groups.

Reservists and active-duty personnel showed similar patterns of needing further depression evaluation and meeting the screening criteria for anxiety symptoms by deployment status category. Previously deployed personnel were significantly more likely to need further depression evaluation than were nondeployed personnel, but showed no differences in anxiety symptoms associated with deployment. Of interest, few reservists or active-duty personnel felt that poor mental health limited their activities in the past month.

The association between deployment status and meeting the screening criteria for PTSD

TABLE 2—Results of Comparative Analyses of Stress and Mental Health: US Department of Defense Surveys of Health-Related Behaviors, 2006 Reserve Component and 2005 Active Duty Component

Stress or Mental Health Variable	Traditional Reserve Component, % (SE)	Full-Time Reserve Component,[a] % (SE)	Active-Duty Component, % (SE)
Stress while carrying out military duties, past 12 mo			
Unadjusted	12.9 (1.3)[b]	18.4 (1.7)[c]	32.5 (0.9)[d]
Adjusted	12.3 (1.1)[b]	19.0 (1.8)[c]	33.2 (0.9)[d]
High stress in family, past 12 mo			
Unadjusted	19.2 (0.7)[b]	16.9 (1.6)[b]	18.9 (0.5)[b]
Adjusted	18.9 (0.6)[b]	18.6 (1.7)[b]	18.9 (0.5)[b]
Need for further depression evaluation			
Unadjusted	18.8 (0.6)[b]	17.7 (1.9)[b]	22.3 (0.8)[c]
Adjusted	17.5 (0.5)[b]	19.0 (1.8)[b]	23.2 (0.8)[c]
Met screening criteria for GAD symptoms, past 30 d			
Unadjusted	10.7 (0.7)[b]	8.0 (0.9)[c]	12.7 (0.5)[d]
Adjusted	10.1 (0.6)[b]	8.5 (1.0)[b]	13.1 (0.5)[c]
Need for further PTSD evaluation, past 30 d			
Unadjusted	7.7 (0.8)[b]	5.4 (0.7)[c]	6.7 (0.5)[b,c]
Adjusted	6.9 (0.6)[b]	6.1 (0.8)[b]	7.1 (0.6)[b]
Stress as a woman[e], past 12 mo			
Unadjusted	22.2 (1.0)[b]	27.2 (3.9)[b]	35.5 (1.2)[c]
Adjusted	21.0 (1.0)[b]	27.9 (3.7)[b]	36.7 (1.2)[c]
Limited usual activities for ≥11 d in past mo because of poor mental health			
Unadjusted	1.9 (0.3)[b]	3.0 (0.6)[b,c]	2.9 (0.2)[c]
Adjusted	1.7 (0.3)[b]	3.8 (0.8)[c]	3.0 (0.3)[c]
Suicidal ideation, past y			
Unadjusted	5.5 (0.4)[b]	4.2 (0.5)[c]	4.9 (0.3)[b,c]
Adjusted	5.0 (0.4)[b]	5.5 (0.6)[b]	5.1 (0.3)[b]
Suicide attempt, past y			
Unadjusted	1.8 (0.3)[b]	0.6 (0.2)[c]	0.8 (0.1)[c]
Adjusted	1.5 (0.2)[b]	0.8 (0.3)[b,c]	0.9 (0.1)[c]

Note. GAD = generalized anxiety disorder; PTSD = post-traumatic stress disorder. Table displays the percentage of reservists and active-duty personnel who reported stress and mental health problems. Adjusted estimates were standardized to gender, race/ethnicity, education, age, marital status, pay grade, and service or reserve component.

[a]Full-time reserve component refers to the Active Guard or Reserve Program and full-time National Guard or reservist.

[b,c,d]Estimates within rows not sharing a common superscript letter differ significantly, $P < .05$.

[e]Estimate is among women only. Refers to those who indicated a "great deal" or a "fairly large amount" of stress with being a woman in the military.

TABLE 3—Results of Comparative Analyses of Stress and Mental Health by Deployment Status: US Department of Defense Surveys of Health-Related Behaviors, 2006 Reserve Component and 2005 Active Duty Component

Stress or Mental Health Variable	Traditional Reserve Component		Active-Duty Component	
	Deployed ≥1 Time, % (SE)	Not Deployed, % (SE)	Deployed ≥1 Time, % (SE)	Not Deployed, % (SE)
Stress while carrying out military duties, past 12 mo				
Unadjusted	14.4 (0.9)[a]	11.2 (2.3)[a]	34.2 (1.0)[b]	29.9 (1.4)[c]
Adjusted	13.8 (0.9)[a]	10.5 (2.0)[a]	35.4 (1.0)[b]	30.3 (1.3)[c]
High stress in family, past 12 mo				
Unadjusted	19.9 (0.6)[a]	18.7 (1.2)[a,b]	19.9 (0.7)[a]	17.7 (0.8)[b]
Adjusted	20.3 (0.7)[a]	18.1 (1.0)[a,b]	20.3 (0.7)[a]	17.6 (0.8)[b]
Need for further depression evaluation				
Unadjusted	19.9 (0.9)[a,b]	17.8 (0.9)[b]	22.6 (0.8)[c]	21.2 (1.2)[a,c]
Adjusted	19.1 (1.0)[a]	16.2 (0.7)[b]	24.0 (0.8)[c]	21.6 (1.0)[a]
Met screening criteria for GAD symptoms, past 30 d				
Unadjusted	10.9 (0.7)[a]	10.3 (1.3)[a,b]	13.0 (0.6)[b]	12.0 (0.9)[a,b]
Adjusted	10.4 (0.7)[a,b]	9.5 (1.0)[b]	13.7 (0.6)[c]	12.2 (0.8)[a,c]
Limited usual activities for ≥11 d in past mo because of poor mental health[e]				
Unadjusted	2.4 (0.4)[a]	1.2 (0.3)[b]	3.1 (0.3)[a]	2.5 (0.4)[a]
Adjusted	2.5 (0.4)[a]	1.2 (0.2)[b]	3.2 (0.3)[a]	2.5 (0.4)[a]
Need for further PTSD evaluation, past 30 d				
Unadjusted	9.0 (0.7)[a]	6.6 (1.2)[a,b]	7.2 (0.6)[b]	5.8 (0.7)[b]
Adjusted	8.4 (0.7)[a]	5.9 (0.8)[b,d]	7.6 (0.6)[a,b]	6.1 (0.8)[d]
Suicidal ideation, past y				
Unadjusted	6.9 (0.4)[a]	4.1 (0.5)[b]	5.1 (0.4)[b]	4.6 (0.4)[b]
Adjusted	7.1 (0.5)[a]	3.8 (0.4)[b]	5.4 (0.4)[b]	4.5 (0.4)[b]
Suicide attempt, past y				
Unadjusted	2.3 (0.4)[a]	1.1 (0.2)[b]	0.9 (0.1)[b]	0.6 (0.2)[b]
Adjusted	2.3 (0.5)[a]	0.9 (0.2)[b]	1.0 (0.1)[b]	0.6 (0.2)[b]

Note. GAD = generalized anxiety disorder; PTSD = post-traumatic stress disorder. Table displays the percentage of reservists and active-duty personnel by deployment status in the past 36 months who reported the stress and mental health issues indicated. Adjusted estimates were standardized to gender, race/ethnicity, education, age, marital status, pay grade, and service or reserve component.

[a,b,c,d]Estimates within rows not sharing a common superscript letter differ significantly, $P < .05$.

[e]Based on respondents' perception of number of days when mental health limited usual activities.

symptoms was similar for reservists and active-duty personnel. Those who had been deployed showed significantly higher proportions of meeting the criteria than did those who were not deployed.

We found notable differences by deployment status between reservists and active-duty personnel in reports of suicidal ideation and suicide attempts. Reservists who had been previously deployed were significantly more likely to report these behaviors than were those who had not been deployed, whereas active-duty personnel showed no significant differences as the result of deployment. Previously deployed reservists also showed higher rates of both suicidal ideation and attempts than did their active-duty counterparts.

Traditional reservists and active-duty personnel are contrasted in Table 4 regarding stress and mental health indicators by operational theater where they served: those who served in OIF or OEF; those who served in other operational theaters, but not OIF or OEF; and those who had not served in an operational theater (i.e., those who had not been deployed to an operational theater). Operational theaters have diverse environmental and mission-related factors associated with them and may therefore differentially affect stress and mental health issues. As shown, higher prevalences of stress and stress-related problems were associated with military operational theaters. Although reservists overall showed lower work stress than did active-duty personnel, those who had served in OIF or OEF in the past 36 months reported significantly higher stress while carrying out military duties than did those in other theaters and those who had not served in a theater. By contrast, active-duty personnel who served in OIF or OEF reported a significantly higher prevalence of stress while carrying out military duties than that reported by those who had not served in a theater. For family stress, reservists who served in OIF or OEF reported

significantly higher family stress than did those who did not serve in a theater, whereas active-duty personnel showed no significant differences in family stress related to theater.

Operational theater was not associated with rates of depression, anxiety symptoms, or mental health limiting normal activities for active-duty personnel but it was associated for reservists. Reservists who served in OIF or OEF were significantly more likely to report symptoms related to mental health than were those who did not serve in a theater. Meeting the screening criteria for symptoms of PTSD differed strikingly between reservists and active-duty personnel by theater. Reservists who served in OIF or OEF showed significantly higher proportions of PTSD symptoms than did active-duty personnel regardless of theater and higher proportions than did reservists who did not serve in a theater but not significantly higher than reservists who served in other theaters.

Suicidal ideation and suicide attempts also showed striking differences between reservists and active-duty personnel by theater. Suicidal ideation or thoughts were more likely to be reported by reservists who served in OIF or OEF or in other theaters than by those who did not serve in a theater. Suicide attempts were significantly higher among reservists

TABLE 4—Results of Comparative Analyses of Stress and Mental Health by Theater of Operation: US Department of Defense Surveys of Health-Related Behaviors, 2006 Reserve Component and 2005 Active Duty Component

Stress or Mental Health Variable	Traditional Reserve Component			Active-Duty Component		
	Served in OIF or OEF, % (SE)	Served in Other Theater,[a] % (SE)	Did Not Serve in Theater, % (SE)	Served in OIF or OEF, % (SE)	Served in Other Theater,[a] % (SE)	Did Not Serve in Theater, % (SE)
Stress while carrying out military duties, past 12 mo						
Unadjusted	16.4 (1.9)[b]	9.3 (1.2)[c]	10.5 (1.6)[c]	33.7 (1.1)[d]	29.6 (1.6)[e]	32.4 (1.7)[d,e]
Adjusted	15.9 (1.6)[b]	10.0 (1.1)[c]	9.4 (1.4)[c]	34.9 (1.1)[d]	33.2 (1.7)[d,e]	31.2 (1.5)[e]
High stress in family, past 12 mo						
Unadjusted	20.9 (1.6)[b]	17.7 (1.4)[b,c]	18.5 (1.3)[b,c]	19.4 (0.8)[b]	16.6 (1.0)[c]	19.8 (1.0)[b]
Adjusted	21.5 (1.2)[b]	19.2 (1.4)[b,c]	17.0 (1.1)[c]	19.8 (0.8)[b]	18.6 (1.2)[b,c]	18.5 (1.0)[b,c]
Need for further depression evaluation						
Unadjusted	21.2 (1.6)[b,d]	16.2 (1.1)[c]	17.5 (1.1)[b,c]	21.6 (0.9)[d]	18.0 (1.2)[b,c]	25.1 (1.6)[d]
Adjusted	20.7 (1.3)[b,d]	17.2 (1.3)[b,c]	15.0 (1.0)[c]	23.1 (0.8)[d]	21.8 (1.2)[d]	23.7 (1.5)[d]
Met screening criteria for GAD symptoms, past 30 d						
Unadjusted	12.7 (1.8)[b,c,d]	9.4 (1.0)[b]	9.3 (0.6)[b]	12.6 (0.7)[c,d]	10.6 (0.9)[b,c]	13.7 (0.8)[d]
Adjusted	12.5 (1.4)[b,d]	10.1 (1.1)[b,c]	8.1 (0.5)[c]	13.3 (0.7)[d]	12.7 (1.0)[b,d]	12.9 (0.8)[d]
Limited usual activities for ≥11 d in past mo because of poor mental health[f]						
Unadjusted	1.8 (0.3)[b,c]	2.8 (0.8)[c,d,e]	1.4 (0.4)[b]	3.2 (0.3)[e]	2.0 (0.3)[b,c,d]	3.0 (0.5)[d,e]
Adjusted	1.9 (0.3)[b]	3.7 (0.9)[b,d]	1.1 (0.3)[c]	3.4 (0.4)[d]	2.9 (0.5)[b,d]	2.5 (0.5)[b,d]
Need for further PTSD evaluation, past 30 d						
Unadjusted	10.7 (1.8)[b]	7.0 (1.0)[c]	5.0 (0.8)[c,d]	7.0 (0.7)[b,c]	4.4 (0.6)[d]	7.3 (0.9)[b,c]
Adjusted	10.1 (1.2)[b]	8.2 (1.1)[b,c]	4.2 (0.6)[d]	7.5 (0.7)[c]	6.1 (0.7)[c,d]	6.7 (0.9)[c]
Suicidal ideation, past y						
Unadjusted	5.9 (0.5)[b]	7.7 (1.4)[b]	3.9 (0.6)[c,d]	4.9 (0.5)[b,c,d]	3.7 (0.6)[d]	5.4 (0.5)[b,c]
Adjusted	6.4 (0.6)[b,d]	9.8 (1.7)[d]	3.1 (0.5)[e]	5.3 (0.5)[b,c]	5.2 (0.8)[b,c]	4.5 (0.5)[c]
Suicide attempt, past y						
Unadjusted	1.4 (0.2)[b,c]	3.9 (1.3)[b]	1.0 (0.3)[c,d]	0.8 (0.1)[d]	0.6 (0.2)[d]	0.8 (0.2)[d]
Adjusted	1.6 (0.3)[b]	5.3 (1.8)[c]	0.7 (0.2)[d]	0.9 (0.1)[b,d]	1.1 (0.3)[b,d]	0.7 (0.2)[d]

Note. GAD = generalized anxiety disorder; OEF = Operation Enduring Freedom; OIF = Operation Iraqi Freedom. PTSD = post-traumatic stress disorder. Table displays the percentage of reservists and active-duty personnel by location of deployment who reported the stress and mental health issues indicated. Adjusted estimates were standardized to gender, race/ethnicity, education, age, marital status, pay grade, and service or reserve component.

[a]Other theater included Operations Desert Shield/Desert Storm (e.g., the Persian Gulf), Operation Just Cause (e.g., Panama), Operation Restore Hope (e.g., Somalia), Operation Uphold Democracy (e.g., Haiti), Operations Joint Endeavor or Joint Guard (e.g., Bosnia), Operation Safe Haven (e.g., Cuba), Tsunami Relief (e.g., South Asia), other combat peace-keeping missions, and other remote assignments (this excludes hurricane relief and Homeland Security and airport security or security for active-duty installations). Respondents serving in OIF or OEF, as well as another theater, appear only in the OIF or OEF column.

[b,c,d,e]Estimates within rows not sharing a common superscript letter differ significantly, $P < .05$.

[f]Based on respondents' perception of number of days when mental health limited usual activities.

who served in OIF or OEF and in theaters other than OIF or OEF than among those who did not serve in a theater. Notably, the proportion for those serving in other theaters was the highest of any reserve-component or active-duty personnel category. Active-duty personnel showed no statistically significant differences by theater.

DISCUSSION

Reservists reported significant mental health issues, particularly as related to deployment. Although high stress and other mental health issues were slightly less common among reservists than among active-duty personnel overall, the higher rates of high stress and other mental health issues among reservists associated with deployment are noteworthy, particularly in the absence of systems designed to deal with these issues specifically in this population. Especially concerning are the higher PTSD symptomatology and significantly greater suicidal ideation and suicide attempts among deployed compared with nondeployed reservists relative to deployed compared with nondeployed active-duty personnel. Our findings suggest a differential impact of deployment on reservists and the need to address the unique requirements of returning reservists as they navigate the reintegration process.

Deployed personnel showed significantly higher rates of meeting the screening criteria for PTSD than did nondeployed personnel. Deployment was also related to perceived work and family stress among active-duty personnel. High family stress was comparable between both groups across deployment categories. Additionally, a greater percentage of both active-duty personnel and reservists who had been deployed reported depression symptoms compared with those who had not been deployed. Reservists who were deployed were significantly more likely to report suicidal ideation and suicide attempts than were their nondeployed counterparts. These findings illustrate the stress that deployment (including the possibility of upcoming deployment) can place on the families of all service members and support growing concerns that deployments are taking a significant toll on the mental health of both active and reserve personnel.[3]

Among reservists, OIF or OEF service was associated with higher levels of family stress and symptoms of depression, anxiety, PTSD, and poor mental health limiting normal activities. Significantly more reservists who served in OIF or OEF showed PTSD symptoms compared with any active-duty personnel and reservists not serving in a theater. Likewise, suicide attempts were significantly higher in all theaters than among those who did not serve in a theater. These findings suggest that deployment to any theater, not only to OIF or OEF, may represent unique threats to the mental well-being of service members. Of particular note was that the highest rate of suicidal behavior was among those reservists who had served in theaters other than OIE or OEF. We are currently examining this unexpected finding with additional analyses; this is an area requiring further research. Consideration of programs and services to address these threats should include a wide range of situational and environmental factors associated with the realities of deployment in general, in addition to those factors associated with specific theaters such as OIF or OEF.

Our findings are consistent with previous data indicating that reservists report similar and in some cases higher rates of mental health issues than do their active-duty counterparts[3] and expand existing research through examination of a broader spectrum of factors related to these issues. The additional stressors that reservists face, including uncertainty associated with workload, environments, and timelines,[2] exacerbate mental well-being issues. For example, although active-duty personnel showed higher rates of depression and anxiety symptoms than did reservists, unlike their active-duty counterparts, reservists do not typically live in a day-to-day culture in which the anxieties associated with deployment are a way of life. Rather, their typical culture involves balancing the competing demands of a military career with that of a civilian career. When deployments do occur, the associated anxieties are not familiar. Reservists also face uncertainty about whether the civilian jobs they left will be available when they return from deployment.

Our findings represent issues that are becoming increasingly salient to policymakers at all levels. Recently proposed legislation underscores the need for the evaluation and implementation of mental health services for reserve-component personnel. In April 2008, the National Guard and Reserve Mental Health Access Act of 2008 was introduced to the US Senate with a focus "to expand and improve mental health care and reintegration programs for members of the National Guard and Reserve."[15] Such legislation will be increasingly important as more service members cycle through the deployment process and return home to their civilian lives.

Limitations

The present study had several limitations that should be considered when interpreting our study findings. The active-duty and reserve-component data were collected 1 year apart (active duty in 2005, reserve component in 2006), and comparisons between the groups may contain bias to the extent that events in the year between the surveys may have influenced the reported behaviors. Specifically, varying events during the periods in the OIF and OEF theaters may have influenced the experiences, and ultimately responses, of both groups. Express examination of the effects of deployment theater on mental health outcomes accounted for some events and their influences, and continuing research should consider these potentially differential effects as related to emergent deployment theaters.

Another limitation was the response rates of the surveys. Although the 52% to 55% response rates were low for civilian surveys, the onsite administration of the health-related behaviors surveys is unique among military surveys and achieved the highest response rate of any population-based military survey. Most personnel unavailable to participate in the survey were deployed, although large numbers of recently deployed personnel participating in the survey provided confidence in the generalizability of the findings. To mitigate potential biasing effects of differential nonresponse, we weighted and adjusted the data to represent the population of eligible active-duty personnel.[16]

Finally, the data were based on self-report and may have been subject to recall errors and ambiguities caused by questions with various interpretations and to potential bias resulting from the sensitive nature of some questions surrounding mental health issues. Some concern exists that personnel might not reveal

information about issues that they believe could jeopardize their military careers. However, because the surveys were pretested and because of the large numbers of respondents, the use of sampling weights, and strong research design and rigorous procedures to encourage honest reporting (including anonymity of survey responses), we believe the extent of potential bias to be small.[16]

Conclusions

The present study provided the first population-based assessment and comparison of mental health issues among active-duty and reserve-component service members. Furthermore, our study extended previous work by incorporating personnel from all service branches rather than focusing on select branches[3,17] or unit types[2] and by examining a broader range of issues in greater depth. Although both active and reserve personnel were impacted by deployment, our findings suggest a differential impact of deployment on reservists and highlight the urgent need for mental health services for this population. Deployed reservists reported greater PTSD symptomatology and suicidal ideation and attempts than did nondeployed reservists, which suggests areas for intervention in this distinct population of service members. Our findings also suggest that deployment to any theater, not only to OIF or OEF, may represent unique threats to the mental well-being of all service members. Continued research efforts aimed at providing services and interventions tailored to reservists will better facilitate the successful return and reintegration of service members experiencing postdeployment mental health issues. ■

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Contributors

M.E. Lane led the drafting of the article. L.L. Hourani and R.M. Bray led the development of the study concept, design, and acquisition of data. All authors contributed to the analysis and interpretation of the data and review of the article for important intellectual content.

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Human Participant Protection

This study was approved by two independent institutional review boards and was deemed to be of minimal risk.

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APPENDIX 4

Tobacco and Alcohol Abuse Correlates of Posttraumatic Stress Disorder in Active Duty and Reserve Component Military Personnel.

Tobacco and Alcohol Abuse Correlates of Posttraumatic Stress Disorder in Active Duty and Reserve Component Military Personnel

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Abstract

The relationship between posttraumatic stress disorder (PTSD) and substance abuse has been studied in the general civilian population and in war veterans. However, little research has been conducted using large population-based samples of either active duty or reserve component military personnel. This study examined the association of smoking and heavy alcohol use and the risk of PTSD in both military components. Data from two population-based surveys of military personnel (1 active duty, N= 16,146; 1 reserve component, N= 18,342) were used to assess these associations. Findings showed a statistically significant interaction between smoking and heavy drinking when modeling the risk for PTSD in active duty personnel but not for reservists. In particular, there was an increased risk for PTSD among current smokers compared to never smokers regardless of heavy drinking status for both active duty and reserve component personnel, although differences were observed between personnel types in heavy drinking status group contrasts. Our findings build on other research conducted among war veterans and emphasize the importance of interventions to address the role of tobacco and alcohol abuse on symptoms specific to PTSD.

Keywords: PTSD, mental health, smoking, substance use, alcohol abuse, military

1. Introduction

Posttraumatic stress disorder (PTSD) is defined in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) as a disorder that develops as a result of a life-threatening experience (Criterion A). Its symptoms are often assessed in surveys using the PTSD Checklist (PCL) (Weathers et al., 1994) and are classified into three domains: re-experiencing (Criterion B), avoidance or emotional numbing (Criterion C), and arousal (Criterion D), resulting in significant impairment to one's functioning (American Psychiatric Association, 2000; Weathers et al., 1994). Many studies use a conservative cutoff score of 50 on the PCL to screen for possible PTSD (Bliese et al., 2007; Dobie et al., 2002; Lang et al., 2003).

PTSD diagnosis and symptoms have been strongly associated with physical health problems, low functional status, poorer health-related quality of life, higher health care utilization for both physical and mental health services, and substance abuse (Dobie et al., 2002; Hoge et al., 2006; Hoge et al., 2007; Jakupcak et al., 2008; Milliken et al., 2007; Ouimette et al., 1997; Ouimette et al., 2004). This broad range of symptoms and problems raises concerns regarding coping mechanisms used by individuals, including the abuse of alcohol, tobacco, or other substances.

Studies of PTSD in military personnel have been conducted among Vietnam War veterans and more recently among individuals returning from combat in Iraq and Afghanistan. Among these veterans, estimates of PTSD range from 11%–20% even 4–6 months following their return from combat (Erbes et al., 2007; Hoge et al., 2004; Hoge et al., 2007; Tanielian & Jaycox, 2008). High rates of comorbid substance use have been observed in both military and civilian samples. Keane et al. (1983) were among the first to report high rates of alcohol and

drug abuse as well as a high intake of nicotine and caffeine among veterans with PTSD. Veterans with PTSD showed a higher prevalence of alcohol abuse, nicotine dependence (ND), lower quitting rates, and major depression (Magruder et al., 2005; Hapke et al., 2005; Feldner et al., 2007; Collie et al., 2004) compared to those without PTSD, even after adjusting for combat exposure (Koenen et al., 2003) and genetic effects (Koenen et al., 2005).

The relationship between substance use and PTSD is a complex one, and the casual relationship is difficult to disentangle. Several hypotheses have been proposed to explain the comorbidity between these disorders. One hypothesis is the *self-medication* hypothesis, which posits that PTSD develops first and that individuals use substances in order to mitigate traumatic memories, or to alleviate painful symptoms of PTSD such as sleep disturbance, intrusive thoughts, or hypervigilance (Brady et al., 2000; Brady et al., 2004; Brown et al., 1994). Several studies have provided support for this theory but are based primarily on clinical observations (Chilcoat et al., 1998). An alternative explanation for the relationship between PTSD and substance use is the *high-risk* hypothesis, proposing that substance users place themselves at a higher risk for trauma exposure due to their high-risk lifestyles and are therefore at a higher risk to develop PTSD (Brady et al., 2000). However, this hypothesis has not received strong validation. A third supported theory, the *susceptibility* hypothesis, suggests that substance abuse may increase an individual's risk for developing PTSD symptoms after a traumatic experience. Another widely held hypothesis (Brady et al., 2000; Brown et al., 1994; Kilpatrick et al., 1997; Kozarić-Kovačić et al., 2000; McFarlane et al., 1998) is the *shared vulnerability* for PTSD and substance use, suggesting that each disorder can increase the risk for the other and lead to a cyclical pattern of chronicity, reflecting a more intricate pathway than the *self-medication, high-risk,* or *susceptibility* theories.

Most studies examining PTSD and smoking or alcohol use have demonstrated a positive significant relationship between them, even after controlling for confounders such as preexisting psychiatric conditions like depression and anxiety, as well as race and education. The data from these studies also suggest that PTSD is more important than trauma exposure alone in the association with tobacco use or ND (Breslau et al., 2003; Fu et al., 2007; Hapke et al., 2005; Scherrer et al., 2008). Among individuals with PTSD, some studies have reported a smoking prevalence above 50%, while other studies have estimated it at 40%–45% (Hébert et al., 2007; Lasser et al., 2000). Regardless of the exact prevalence, these estimates are all substantially higher than the smoking prevalence in either the general population or in active duty and reserve component personnel (20.8%, 32.2% [unadjusted], and 23.7% [unadjusted], respectively) (Hébert et al., 2007; CDC, 2007; Bray et al., 2006; Hourani et al., 2007; Lasser, et al., 2000). Alcohol abuse or dependence also shows frequent comorbidity with PTSD. A national survey reported that 51.9% of individuals with PTSD were also abusing alcohol (Kessler at al., 1995). Other studies also reveal an association between alcohol abuse and PTSD arousal symptoms (McFall et al., 1992; Stewart et al., 1998).

Efforts to understand the directionality of the association between PTSD and tobacco and alcohol use have found support for most of the theories discussed above. One set of findings proposes that veterans with a history of ND and U.S. military personnel with a history of smoking demonstrate an increased risk for PTSD (Koenen et al., 2005; Smith et al., 2008), providing support for the *susceptibility* theory. Other findings posit that PTSD increases the risk of smoking at all genetic liability levels, showing that PTSD represents a non-genetic pathway to late-onset daily smoking for individuals who were nonsmokers (Breslau et al., 2004; Koenen et al., 2006; Hapke et al., 2005). This suggests that persons with PTSD may turn to substance use

and abuse as a coping mechanism (self-medication) for their symptoms (Beckham et al., 1997). Further, there is evidence that smoking is related to specific PTSD symptoms since these individuals with PTSD may smoke to reduce hyperarousal or re-experiencing of traumatic military memories (Beckham et al., 1995; Beckham et al., 1997). In particular, recent data from Cook et al. (2009) suggest that veterans who endorse higher levels of emotional numbing were also more likely to endorse heavy smoking (≥ 20 cigarettes per day), compared to light (1–9 cigarettes per day) or moderate smoking (10–19 cigarettes per day). Nevertheless, Brown et al. (1995) point out that regardless of whether PTSD preceded substance abuse or vice versa, both disorders are intertwined, and individuals with PTSD will use substances to manage their PTSD symptomatology unless they can develop better skills to mitigate their symptoms.

This cycle of PTSD and substance use seems to be particularly relevant to military populations who can be exposed to multiple deployments, which may in turn prolong the cycle of comorbidity. It is around this *shared vulnerability* hypothesis that we center our study; that is, we propose that U.S. military personnel with a history of smoking and alcohol abuse will demonstrate an increased risk for PTSD and that these individuals may subsequently be at risk for further substance abuse to relieve their symptoms. We also hypothesize that the joint effect between both substances will produce a larger increase in the risk of PTSD compared to the two separate main effects, and that tobacco use will particularly accentuate the joint association. Of importance, this study examines the interaction effect of smoking and heavy drinking, which to our knowledge has not been studied among veterans or current military personnel. Further, our analysis presents the differences across several heavy drinking and smoking levels. We also examine the relationship between tobacco and alcohol use in PTSD across military branches and active duty and reserve components.

2. Materials and Methods

2.1. Participants and Sampling Design

Data were drawn from the 2005 Department of Defense (DoD) Survey of Health Related Behaviors Among Military Personnel (Bray et al., 2006) and the 2006 DoD Survey of Health Related Behaviors in the Reserve Component (Hourani et al., 2007). Both surveys employed similar sampling designs and data collection methods. Sample sizes for the 2005 active duty survey and the 2006 reserve component survey were 16,146 (51.8% response rate) and 18,342 (55.3% response rate), respectively. Data for both components were merged for a total of 29,263, and reservists who were in the Active Guard/Reserve Program and/or full-time National Guard/Reservists (AGR/FTS/AR) were dropped from the analyses. Questions contained information designed to assess the prevalence of drug, alcohol, and tobacco use, and other risky health behaviors among active duty and reserve component personnel for each branch of service. Branches for both active duty and reserve personnel consisted of the Army (including Army National Guard and Army Reserve), Navy (including Naval Reserve), Marine Corps (MC) (including MC Reserve), and Air Force (AF) (including Air National Guard and AF Reserve).

The survey populations included all active duty and reserve component personnel at the time of data collection, except for recruits, academy cadets, and personnel who were absent without leave (AWOL), incarcerated, or undergoing a permanent change of station. For the active duty survey, first-stage sampling consisted of random selection of installations or ships within each service, within and outside of the continental United States. For the second-stage sampling, personnel were randomly selected at installations and were stratified by service, gender, and paygrade; this stage also included remote personnel at the outset. For the reserve component, a sampling frame was constructed by collapsing units into the facilities that they

served. The first three digits of the unit's ZIP code were used as a rough measure to indicate a geographic cluster from which they were randomly selected. Data collection occurred in two phases for the voluntary and anonymous surveys. The first consisted of on-site group administrations by civilian teams, and the second consisted of mailing questionnaires to eligible participants who did not attend on-site administrations. Additional details on the sampling and measures can be found in the final technical reports for the active duty and reserve component surveys (Bray et al., 2006; Hourani et al., 2007).

2.2. Key Measures

2.2.1. Substance use

Smokers were defined as (1) having smoked in the 30 days prior to the survey and (2) having smoked more than 100 cigarettes during their lifetime. Heavy drinking was defined as drinking five or more drinks (four for women) per occasion at least once a week in the 30 days prior to the survey. Initial data runs were conducted separately by former and never smokers, but former smokers were excluded from the logistic models due to their heterogeneous behavior (i.e., they can behave like both current and never smokers).

2.2.2. PTSD Checklist (PCL)

The PCL-civilian version (PCL-C) (Weathers et al., 1994) was used for both surveys. The checklist is a 17-item questionnaire that asks about experiences related to PTSD. The civilian version was used instead of the military version (PCL-M) in order to capture PTSD symptoms resulting from nonmilitary experiences prior to enrolling in the military. The two versions differ only in the instructions, not in PTSD criteria. Respondents were asked to rate each of the 17

items on a 1–5 Likert scale. A sum for all items was computed for a total score of 17–85; a cutoff value of a sum ≥ 50 was used to classify personnel as screening positive for PTSD. Although cutoff scores range from 35–50 for increased sensitivity, we chose the more conservative but more widely used value of 50 to insure greater specificity.

2.3. Statistical Analyses

Data analyses for this study were performed using SUDAAN (RTI, 2008). Because the data from both components were combined, a survey weight was calculated to account for differences between active duty and reserve respondents and to make inferences from these two populations to the entire military population.

Logistic regressions were conducted to examine predicted marginals modeling the risk for PTSD according to smoking and heavy drinking status, as well as the interaction effect between smoking and heavy drinking. Predicted marginals are adjusted prevalence estimates from regression models that control for different covariate distributions. Models controlled for age group, service branch, race/ethnicity, gender, marital status, and deployment.

3. Results

Table 1 provides a summary of the distributions for demographic, substance abuse, and PTSD variables. The demographic characteristics of active duty and reserve component personnel had similar distributions for gender, race/ethnicity, paygrade, marital status, and heavy drinking, but had different distributions for service branch, age group, education, number of deployments, and smoking rates. With regard to service branch, the majority of reservists were in army components whereas active duty personnel were more dispersed among the branches.

Compared to reservists, active duty personnel were also younger, more likely to have been deployed, and more likely to smoke cigarettes.

Table 1 also shows PTSD rates within the demographic groups. The distributions are quite similar for the active duty and reserve component personnel with a few exceptions. One of the most notable exceptions is for age. Active duty service members show high rates for persons aged 25 or younger (10.1%), but notably lower rates for those aged 26 or older (3.8%). Reservists, in contrast, showed similar rates for both age groups (8.5% vs. 7.4%). This same pattern occurs for enlisted and officer personnel, with active duty enlisted personnel having higher rates than officers (7.8% vs. 1.7%), but reservists showing the same rate for enlisted personnel and officers (7.8%). Active duty personnel and reservists showed similar rates of PTSD among current smokers (CS) relative to never smokers (NS) or former smokers and for heavy drinkers compared to non-heavy drinkers.

{insert Table 1 about here}

The association and interaction between smoking and heavy drinking are presented in Table 2. These logistic regression models measure the risk of PTSD among CS compared to NS, across heavy drinking status, for active duty and reserve component personnel separately. An important caveat is that the risk measures present the association between PTSD and the smoking and drinking predictors; they do not imply causality.

Overall adjusted estimates for the active duty cohort indicate that Army service members experienced an 83% increased risk of PTSD, while the Marine Corps showed a 38% excess risk (each compared to the Air Force); results for the Navy were not statistically significant. In addition, individuals aged 25 years or younger showed a nearly twofold significantly higher risk of PTSD compared to those aged 26 or older, while individuals with a race other than Non-

Hispanic White reported a 24% increased risk of PTSD, and unmarried personnel showed a 33% higher risk compared to their married counterparts.

The interaction effect between both substances was statistically significant in the active duty cohort (Wald F=22.81, p-value=<.0001), indicating that the impact of one substance was conditional on use of the other. According to the simple main effects of smoking status within the heavy drinking category, the risk of PTSD for CS relative to NS was significantly greater for non-heavy drinkers (OR = 2.88) than for heavy drinkers.

For the reserve component, analysis of variance results indicate the overall logistic model was statistically significant, but the interaction term was not (p = 0.658); hence, the interaction term was removed from the model and only the main effects were reported. From the adjusted ORs, the Army had over three times the risk of PTSD, and the Marine Corps had nearly three times the risk, both compared to the Air Force. Estimates also demonstrate that current smokers were 1.6 times more likely to be at risk for PTSD, while heavy drinkers were at almost 1.7 times the risk.

{insert Table 2 about here}

Table 3 examines the results from Table 2 with the purpose of estimating predicted marginal proportions (i.e., model-adjusted risks) for each cross classification of smoking and heavy drinking status, and the model-adjusted risk ratios (prevalence ratios calculated from the ratio of marginal proportions). Since the interaction effect was not statistically significant in the reserve component, only predicted marginal proportions are presented for this cohort.

First, the model-adjusted marginals (according to the interaction between smoking and heavy drinking status) show there was a prevalence of PTSD of 10.0% among active duty CS

who were also heavy drinkers. In addition, there was a 7.2% prevalence of PTSD for NS who were heavy drinkers; therefore, the prevalence of PTSD was higher for CS than for NS, corresponding to the 1.39 estimate in Table 2. For non-heavy drinkers, the prevalence of PTSD was again higher for CS than for NS, but the risk difference between CS (10.7%) and NS (4.0%) was much greater than among heavy drinkers (corresponding to the 2.88 OR in Table 2). In the reserve component cohort, the prevalence of PTSD in the heavy drinking group was 10.2% for CS, 6.8% for NS, 11.3% for heavy drinkers, and 7.0% for non-heavy drinkers. All marginals were statistically significant at $p < 0.0001$.

The next section of the table presents the model-adjusted odds ratios for the AD cohort, where the estimated risk ratios for non-heavy drinkers vs. heavy drinkers were 1.07 among CS and 0.55 among NS (only results for NS were statistically significant). The additive impact of heavy drinking on PTSD risk was negligible for current smokers, but significant for NS. Active duty NS who were non-heavy drinkers were 45% less likely than heavy drinkers to be at risk for PTSD. Results for RC personnel are not presented in light of the lack of significance in the interaction term.

To summarize, the data in the active duty cohort indicate that the risk of PTSD was higher for CS compared to NS regardless of heavy drinking status. Interestingly, among CS, the risk of PTSD was slightly higher for non-heavy drinkers than for heavy drinkers. Conversely, the risk of PTSD in NS was higher for heavy drinkers.

{insert Table 3 about here}

4. Discussion

4.1. Overview of Findings

The main purpose of this study was to explore tobacco and heavy alcohol use and their relationship to PTSD among active duty and reserve component personnel. Although the association between PTSD and substance abuse has been shown in prior studies, our effort was unique in studying this large and representative military population and in examining interactions to better understand the role of heavy alcohol use and tobacco use on the risk for PTSD.

A key finding was the decreased risk of PTSD among active duty smokers who were heavy drinkers in contrast to smokers who were not heavy drinkers. One explanation may be that smoking combined with increased drinking helps individuals cope more effectively with their symptoms than smoking alone, reflecting the cycle of shared vulnerability with PTSD. The association of smoking and PTSD is particularly important because evidence suggests that individuals may smoke to reduce craving and distressing symptoms, which have been shown to decrease in smokers with and without PTSD, regardless of the presence of nicotine in their cigarettes (Beckham et al., 2005). This reduction in symptoms was also shown by Beckham et al. (2007) who examined the effects of smoking on script-driven imagery in the presence and absence of PTSD. They found that smoking reduced smoking craving, negative affect, and PTSD symptoms for smokers with and without PTSD, regardless of the presence of nicotine in their cigarettes, and reduced PTSD symptoms in response to a trauma or stressful script (Beckham et al., 2007).

Overall, our findings support the hypothesis that tobacco use in particular increased the risk for PTSD in the U.S. military population, with conflicting results between active duty and reserve component personnel for heavy drinking. Although we cannot determine causality with cross-sectional data, the strong association observed among CS at risk for PTSD suggests that smoking may predispose individuals to PTSD and that these individuals may later smoke to self-medicate. These observations are also consistent with findings by Koenen et al. (2005), who performed survival analyses based on four proposed models of directionality and found that the strongest association was explained by the fact that preexisting ND increased the risk of PTSD onset in individuals exposed to trauma (an almost twofold risk), even after controlling for comorbidities and potential confounders.

4.2. Study Limitations

Despite this study's representativeness of military service members and the fact that it builds on prior research examining veterans and civilians, several limitations exist. One of these limitations is the possibility of underestimating the true effect of the PTSD–smoking/heavy drinking association by using the more validated but higher PCL cutoff value of 50; however, few recent studies show that a lower value may be more beneficial in identifying PTSD in various populations, ranging from 30–34 (Bliese et al., 2008; Yeager et al., 2007) to 44 (Terhakopian et al., 2008). Another limitation is that deployment data could be confounded because service members can be exposed to Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) but remain afloat and not be involved in ground-level combat. Our analysis also did not control for combat exposure specific to OIF/OEF. Finally, although associations between smoking/heavy drinking and PTSD were observed, our study design does not allow us to make conclusions about causality or temporality. Despite these limitations, the results of this

study are valuable because they expand the current knowledge on PTSD and smoking/heavy drinking to include the active duty and reserve military populations.

4.3. Implications and Recommendations

The implications of this study are important for smokers and drinkers with PTSD, mainly because smokers with PTSD have especially low quit rates (Lasser et al., 2000) and because alcohol use can mask the association with the comorbid PTSD by modifying its symptoms (McFarlane, 1998). It is crucial for this population to receive appropriate interventions focused on smoking or drinking and relapse prevention. The importance of interventions has been emphasized in several studies. McFall et al. (2005) reported that only 12% of smokers with PTSD completed smoking cessation programs with their PTSD providers and that the abstinence rate of smokers with PTSD completing smoking cessation programs through the Department of Veterans Affairs (VA) was only 3%. In addition, individuals in integrated care (i.e., brief smoking cessation interventions combined with ongoing mental health care) were more likely to participate in a greater number of smoking cessation counseling sessions compared to those in the usual standard of care (i.e., cessation interventions separate from mental health care) (McFall et al., 2005). Furthermore, Collie et al. (2004) indicated that most help-seeking veterans reported not receiving smoking cessation assistance during the previous year and that psychiatric patients who attended their routine mental health or primary care visit were infrequently offered smoking cessation treatment. Newer research by McFall et al. (2006, 2010) emphasized the dynamic relationship between PTSD and tobacco use, and the importance of an integrated approach by focusing on treating both disorders simultaneously, particularly since evidence suggests this approach provides a longer abstinence period. Of note, DoD currently mandates that smoking

cessation treatment be made available to military personnel, and the same is true of the VA. This is particularly important in light of difficulties in maintaining smoking cessation.

The following are some recommendations for health providers who treat smokers with PTSD in the military: (1) grant patients access to smoking cessation guidelines and ensure follow-up and monitoring; (2) grant patients access to new smoking cessation treatments/medications and training on skills to prevent relapse; (3) counsel patients to reduce the number of daily cigarettes smoked if quitting is undesired or unfeasible, particularly in highly nicotine-dependent patients (Collie et al., 2004); and (4) provide an integrated cessation approach, as mentioned above. These interventions will benefit this cohort because smoking is also associated with numerous adverse health outcomes, including cardiovascular and respiratory conditions and several types of cancer.

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Table 1

Demographic characteristics and substance abuse indicators according to presence of PTSD among active duty and reserve component personnel*

Variable	Active Duty		Reserve Component, excluding AGR/FTS/AR[a]	
	Total %	**PTSD N (%)**	**Total %**	**PTSD N (%)**
Branch[^]				
Total DoD	N = 15,632	896 (6.7)	N = 13,631	691 (7.8)
Army	32.6	**306 (9.4)**	65.5	**302 (9.8)**
Navy	26.3	**248 (6.3)**	9.9	**103 (3.3)**
MC	12.8	**185 (7.6)**	4.8	**72 (7.4)**
AF	28.3	**157 (3.7)**	19.8	**214 (3.3)**
Age groups				
≤ 25 years old	46.8	**549 (10.1)**	36.1	264 (8.5)
≥ 26 years old	53.2	**347 (3.8)**	63.9	427 (7.4)
Gender				
Male	85.4	626 (6.7)	82.2	496 (7.5)
Female	14.6	270 (6.9)	17.8	195 (9.2)
Race/Ethnicity				
White/Caucasian	64.6	503 (6.6)	67.5	374 (8.2)
Others	35.4	393 (7.0)	32.5	317 (7.0)
Paygrade				
Enlisted	83.1	**824 (7.8)**	85.8	648 (7.8)
Officers	16.9	**72 (1.7)**	14.2	43 (7.8)

Variable	Active Duty		Reserve Component, excluding AGR/FTS/AR[a]	
	Total %	PTSD N (%)	Total %	PTSD N (%)
Education				
≤ High school	33.8	**383 (10.3)**	**24.8**	**174 (12.7)**
Some college	44.1	**414 (6.3)**	**48.0**	**374 (7.3)**
≥ College graduate	22.1	**99 (2.1)**	**27.2**	**143 (4.3)**
Marital Status				
Married/LAM	58.9	**459 (5.1)**	57.5	352 (7.6)
Unmarried	41.1	**437 (9.1)**	42.5	339 (8.1)
Number of Deployments				
No deployment	43.7	313 (5.8)	62.3	331 (6.8)
1+ times	56.3	550 (7.2)	37.7	310 (9.4)
Smoking				
Never smokers	54.3	**355 (4.4)**	62.4	**346 (6.3)**
Current smokers	32.0	**428 (11.5)**	23.3	**238 (12.4)**
Former smokers	13.7	**110 (4.8)**	14.3	**94 (6.4)**
Heavy Drinking				
Yes	18.5	**233 (10.6)**	16.0	**166 (12.5)**
No	81.5	**574 (5.5)**	84.0	**457 (6.6)**

***** Positive screening for PTSD was based on a PCL cutoff value of 50. OEF = Operation Enduring Freedom; OIF = Operation Iraqi Freedom.
% = row percentages. Total % = marginals. Cell sizes may not add up to total N due to missing observations.
[a] AGR/FTS/AR refers to the Active Guard/Reserve Program and/or full-time National Guard/Reservist.
^For Reserve Component Personnel: Army category includes Army National Guard (ARNG) & Army Reserve (USAR), Navy category includes Naval Reserve (USNR), Marine Corps category includes Marine Corps Reserve (USMCR), and Air Force category includes Air National Guard (ANG) & Air Force Reserve (USAFR).
Bolded estimates reflect statistically significant differences between groups at $p < 0.05$.

Table 2

Effects of smoking and heavy drinking on the risk of PTSD, controlling for sociodemographic predictors, and measuring the interaction between smoking and heavy drinking on the occurrence of PTSD

	Active Duty	**Reserve Component, excluding AGR/FTS/AR[‡]**
Predictors	**Risk of PTSD (adjusted ORs with CIs)**	**Risk of PTSD (adjusted ORs with CIs)**
Branch[^]		
Army	**1.83 (1.41, 2.38)**	**3.44 (1.95, 6.08)**
Navy	1.26 (0.90, 1.76)	1.10 (0.75, 1.62)
Marine Corps	**1.38 (1.03, 1.86)**	**2.77 (1.39, 5.51)**
Air Force	1.00	1.00
Age		
≤ 25 years	**1.95 (1.56, 2.45)**	0.78 (0.43, 1.42)
≥ 26 years	1.00	1.00
Race/Ethnicity		
Non-Hispanic Whites	1.00	1.00
Others	**1.24 (1.05, 1.48)**	0.72 (0.41, 1.29)
Gender		
Male	1.00	1.00
Female	1.12 (0.80, 1.59)	1.46 (0.96, 2.22)
Marital Status		
Married/LAM	1.00	1.00
Not married	**1.33 (1.05, 1.70)**	1.03 (0.68, 1.57)

(continued)

Table 2 (continued)

Deployment		
1+ times	1.18 (0.96, 1.45)	1.17 (0.67, 2.04)
No deployment	1.00	1.00
Smoking		
Current smokers	**2.88 (2.15, 3.86)**	**1.61 (1.04, 2.50)**
Never smokers	1.00	1.00
Heavy Drinking		
Yes	**1.90 (1.30, 2.76)**	**1.68 (1.21, 2.34)**
No	1.00	1.00
Interactions		
Current smoker, heavy drinker	**0.48 (0.36, 0.65)**	—
Current smoker, non-heavy drinker	1.00 (1.00, 1.00)	—
Simple Main Effects		
Current vs. never smoker, heavy drinker	1.39 (0.91, 2.13)	—
Current vs. never smoker, non-heavy drinker	**2.88 (2.15, 3.86)**	—

[a] AGR/FTS/AR refers to the Active Guard/Reserve Program and/or full-time National Guard/Reservist.
^For Reserve Component Personnel: Army includes Army National Guard (ARNG) & Army Reserve (USAR), Navy includes Naval Reserve (USNR), Marine Corps includes Marine Corps Reserve (USMCR), and Air Force includes Air National Guard (ANG) & Air Force Reserve (USAFR).
LAM = living as married.
Educational status and paygrade were not included in logistic regression models due to multicollinearity with age.

Table 3

Predictive marginals modeling risk of PTSD according to the interaction of smoking and heavy drinking status

	Active Duty			**Reserve Component, excluding AGR/FTS/AR[a]**
Group	**% (SE)***	**Predicted Marginal Risk Ratio (CI)**	**Group**	**% (SE)***
Current smoker, heavy drinker	**10.0 (1.2)**		Current smoker	**10.2 (1.2)**
Current smoker, non-heavy drinker	**10.7 (1.2)**		Never smoker	**6.8 (1.2)**
Never smoker, heavy drinker	**7.2 (1.4)**		Heavy drinker	**11.3 (1.6)**
Never smoker, non-heavy drinker	**4.0 (0.6)**		Non-heavy drinker	**7.0 (1.0)**
Heavy drinker, never vs. current smoker		0.72 (0.49, 1.06)		
Heavy drinker, current vs. never smoker		1.39 (0.94, 2.06)		
Current smokers, non-heavy vs. heavy drinker		1.07 (0.83, 1.37)		
Never smoker, non-heavy vs. heavy drinker		**0.55 (0.39, 0.78)**		

*Percentages presented are predicted marginals, which were statistically significant at $p < 0.0001$ for both cohorts.

APPENDIX 5

Mental health and substance abuse comorbidities of deployed and nondeployed military personnel with current PTSD symptoms.

Running Head: COMORBIDITIES IN MILITARY PERSONNEL WITH PTSD

Mental Health and Substance Abuse Comorbidities in Military Personnel with Current PTSD Symptoms

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The opinions or assertions contained herein are the private views of the authors, and are not to be construed as official, or as reflecting true views of the Department of Defense.

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Abstract

Deployment and trauma are associated with a number of mental health problems experienced by military personnel. Many of these co-occur, including posttraumatic stress disorder (PTSD), depression, suicidal ideation and attempt, alcohol and drug abuse, and anxiety. This study describes the prevalence and underlying structure of PTSD comorbid mental health conditions in the military. Subjects were 24,690 active duty military personnel from all branches of services who responded to a population-based anonymous survey. Standardized screening instruments were used to obtain prevalence rates of PTSD, depression, generalized anxiety, serious psychological distress, suicidal ideation, and problem drinking. Almost 32% of personnel who met screening criteria for PTSD also met criteria for at least one of five other mental health problems; 75% of those with depression symptoms also met criteria for at least one of the other mental health problems. Latent class analysis models identified five classes of PTSD comorbidity among deployed personnel and four classes among nondeployed personnel. Separate profiles of risk and protective factors differentiated comorbid classes. Findings advance our understanding of the prevalence of co-occurring disorders with PTSD and how individual and military factors may influence both the risk of PTSD and co-occurring mental and substance use disorders.

Keywords: PTSD, military, comorbidity, mental health, substance abuse, survey

Posttraumatic stress disorder (PTSD) has been associated with comorbidity of many somatic and mental disorders (Keane & Wolfe, 1990; Brady et al, 2000). Approximately 80% of people with PTSD have a co-occurring psychiatric disorder at some time in their life (Foa, 2009). Studies of psychiatric inpatients have found that over 75% of PTSD patients had other psychiatric or medical diagnoses (Floen & Elkit, 2007; Jakovljevic et al, 2006). Among the co-occurring conditions associated with PTSD are depression, suicidal ideation and attempt, alcohol and drug abuse, anxiety, conduct disorder, chronic pain, and metabolic syndrome (Floen & Elkit, 2007; Jakovljevic et al, 2006; Campbell et al, 2007).

Researchers have postulated at least three main constructs or hypotheses for the comorbidity of PTSD: (1) comorbidity is a reaction to or complication of PTSD, such as the self-medication hypothesis applied to PTSD and substance abuse relationships; (2) trauma leads to multiple disorders, i.e., shared vulnerability factors (including genetic influences) and/or a global level of distress; and (3) comorbidity is a diagnostic artifact or epiphenomenon of the diagnostic criteria used and is a result of symptom overlap (Wittman et al, 2008; Brady et al, 2000). Previous reviews of the literature (e.g., Brady et al., 2000; Keane & Wolfe, 1990; Keane & Kaloupek, 1997; Kessler et al., 1995) and theoretical models (Asmundson, Stein, & McCreary, 2002; McMillen et al 2002; Wittman et al., 2008) have confirmed the complex relationship between PTSD and other psychiatric disorders and the potential for all three models to play a role depending on the extent and pattern of comorbidity (Brady et al, 2000). Unfortunately, past efforts have typically examined PTSD with only one or a very limited number of other mental and substance use disorders that may contribute to PTSD's onset, duration, and disability. Examining a more comprehensive number of mental health measures and modeling the

uniqueness of their profiles may aid in understanding the patterns and potential treatment implications of PTSD comorbidity.

Understanding PTSD comorbidity is especially important for military personnel who are at high risk for PTSD and other combat-related mental disorders (Department of the Army, 2012). In 2008, approximately 11% of the U.S. active duty military population met screening criteria for PTSD symptoms, 21% screened positive for depression symptoms, 14% met criteria for generalized anxiety disorder, and 20% reported heavy alcohol use (Bray et al, 2010). Although these individual prevalence rates of selected mental health symptom measures have been estimated, the prevalence and pattern of their comorbidities within the total active force have not been examined. It is hypothesized that diagnoses will cluster together depending on different sets of risk and protective factors. Although some of these comorbidities may be associated with combat-related traumas, others may be more associated with separate noncombat risk and protective factors such as childhood trauma, cognitive abilities, sociodemographic factors, or genetic factors. Such comorbidities also pose increased treatment challenges, especially for a vulnerable population that already tends to underutilize treatment services (Grieger et al, 2006).

Because different comorbid patterns may represent different underlying etiologies, optimal intervention and treatment efforts need to take them into account. These efforts require two concurrent lines of investigation: (a) identification of multiple patterns of disorders and (b) examination of risk and protective factors for each comorbid pattern. This study is the first to examine both critical lines of investigation in a large population-based representative sample of active duty military personnel with multiple standardized mental health screening measures and a wide range of potential risk and protective factors.

The overriding goal of this research was to develop models of PTSD comorbidity risk from a wide array of deployment, stress, trauma, and mental health factors that will help guide future research hypotheses, treatment approaches, and interventions. Three specific aims were addressed: (1) describe the prevalence of PTSD comorbid mental health conditions among active duty military personnel, (2) identify the underlying structure of co-occurring PTSD with substance use and mental disorders, and (3) examine variation in the underlying structure across subgroups defined by military characteristics (e.g., service, deployment experience, pay grade) and individual characteristics (e.g., psychosocial stressors, age, race/ethnicity, gender, education).

Methods

In-depth secondary analyses of the 2008 Department of Defense (DoD) Survey of Health Related Behaviors Among Active Duty Military Personnel (HRB Survey) were conducted to address the specific aims of the study. Of 35,221 sampled DoD (non-Coast Guard) service members, the 2008 HRB Survey consisted of 24,690 survey respondents stratified by pay grade, gender, and location representing the total active force (5,927Army, 6,637 Navy, 5,117 Marine Corps, and 7,009 Air Force). A two-stage replacement cluster sample proportional to size was employed in which geographic areas were clustered and randomly selected in the first stage and individuals within the clusters were randomly selected in the second stage. All active duty members were eligible except for recruits, academy cadets, and persons who were absent without leave or incarcerated. The response rate was 70.6%, and data were weighted to represent all active duty personnel and adjust for nonresponse. The majority (97%) of the 32-page anonymous self-report questionnaires were obtained during on-site visits by the study team. The rest were obtained from questionnaires mailed to respondents who were unable to attend group sessions. Institutional Review Board approval was obtained from RTI International and DoD. Additional sampling and methodological details have been reported and published elsewhere (Bray et al, 2010; Bray et al, 2009).

Measures

Variables were used either as indicators of the PTSD comorbidity profiles or as factors hypothesized to predict class or profile membership. An item asking about how many deployments a respondent had had in the past year was used to divide the sample into deployed and nondeployed groups.

Anxiety. The HRB Survey included a set of items adapted from the Patient Health Questionnaire (Spitzer, Kroenke, & Williams, 1999) to assess generalized anxiety disorder (GAD) symptoms. If respondents reported feeling nervous, anxious, or "on edge," or that they had been worrying about different issues for several days, then other symptoms were examined. Respondents who also reported experiencing three or more symptoms on more than half of the past 30 days were considered to have met the screening criteria for GAD. A binary variable was used to indicate whether each case had met or not met screening criteria.

Depression. Need for further depression evaluation was assessed using the three-item Version A Burnam depression screen (Rost, Burnam, & Smith, 1993). Personnel were defined as needing further evaluation or assessment if they (a) felt sad, blue, or depressed for 2 weeks or more in the past 12 months *or* (b) reported 2 or more years in their lifetime of feeling depressed and felt depressed "much of the time" in the past 12 months, *and* (c) felt depressed on 1 or more days in the past week. This scale has shown high sensitivity and good positive predictive value for detecting depressive disorder (Burname, Wells, Leake, & Landsverk, 1988). Possible depression was indicated as a dichotomous item.

Psychological distress. Psychological distress was measured using the K6, a six-item global assessment of depression and anxiety validated in epidemiological studies (Kessler et al., 2002) that asked respondents how often in the past 30 days they felt nervous, hopeless, restless or fidgety; felt so depressed that nothing could cheer them up, felt that everything was an effort, and felt worthless. Items had a five-point response scale ranging from 0 = *none of the time* to 4 = *all of the time*. Items were summed, and a cutoff of 13 was used to indicate significant clinical problems as recommended by Kessler et al., 2002).

PTSD. PTSD symptom severity was assessed using the PTSD Checklist, Civilian Version (PCL-C) (Weathers et al., 1993). This consists of a 17-item self-report instrument that asks respondents to rate the extent to which they have been bothered by PTSD symptoms during the previous 30 days using a five-point scale (1 = *not at all*, 5 = *extremely*). PCL-C items parallel DSM-IV PTSD symptom criteria B, C, and D, and a variety of studies support the use of the PCL-C as a valid and reliable screening instrument (e.g., Keen et al., 2008; Ruggiero et al., 2003). The HRB Survey, and other DoD studies, prefer the PCL-C over the military version of the PCL because the military version ignores symptoms from non-military experiences and can miss common causes of deployment or war-related PTSD in women (e.g., sexual assault rather than combat) as well as deployment-related exacerbations of PTSD symptoms if the original inciting trauma is not military related (Weathers et al, 1993). Item scores were summed and a cutoff of 50 was used to classify persons as likely having PTSD.

Suicidal ideation. Suicidal ideation was assessed by asking respondents about the occurrence of suicidal thoughts within the past year. A dichotomous item indicated any thoughts of suicide vs. none. This particular item has also been used as a first-level screen for suicidal ideation in previous studies of military personnel (e.g., Bray et al., 2010).

Problem drinking. Potentially problematic alcohol consumption was measured with the Alcohol Use Disorders Identification Test (AUDIT) (Babor et al, 2001). The AUDIT was developed as a brief screen for problem drinking and consists of 10 items scored from 0 to 4. Item scores were summed to compute an AUDIT score which could range from 0 to 40. Persons with scores of 16 or greater were classified as having harmful drinking or alcohol dependence. Our cutoff score of 16 was more conservative than 8 or more that is often used for indicating problem drinking.

Predictor variables for class membership. Comorbidity profile membership was conditioned on a variety of demographic and military-related factors. Demographics included service branch (Army, Navy, Marine Corps, or Air Force), race/ethnicity (white non-Hispanic, African American non-Hispanic, Hispanic, other), age (17–29, 30 and older), and gender. Two binary items indicated if a respondent had been prevented from engaging in usual work or recreation activities on 1 or more days in the past month due to poor physical or poor mental health. Several stress measures were also used. Two binary indicators of significant work and family stress were created from individual items. Significant stress was coded as present if responses to these two items included *a lot* or *some*, the top two responses on a five-point scale ranging from *none* to *a lot*. A third stress measure was calculated as the mean stress resulting from life events, including a family death, divorce or breakup, financial problems, housing problems, personal health issues, family health problems, problems with children, or unexpected event/major problem (e.g., hurricane robbery, flood). A single item coded any indication of physical abuse/mistreatment from childhood until entering the military. Sleep quantity was entered as a three-level variable coding 7 or more hours, 5–6 hours, and 4 or fewer hours of sleep on average over the past 6 months. The impulsivity subscale of the Risk-Taking Disposition Scale was used to calculate mean values for a four-point scale of impulsive behaviors (e.g., "I often act on the spur of the moment without stopping to think") from *not at all* to *quite a bit* (Cherpital, 1999). A binary item compared those who were *not at all* or *a little* to those who were *some* or *a lot* impulsive. Two coping scales were used to measure divergent styles for reacting to stressful events. The first, avoidant coping, was measured with two items that assessed use of tobacco and alcohol when confronted with stress. The second, active coping, was a composite of

six problem-directed or emotionally supportive reactions to stress, including prayer, talking to friends or family, and making plans for dealing with the problem.

Analysis

The primary analysis for this study was LCA (McCutcheon, 1987). LCA is a cross-sectional mixture modeling approach that uses observed values to sort cases into subgroups. LCA was used to determine the number and composition of statistically and conceptually distinct classes or profiles of comorbidity in deployed and nondeployed personnel. All models were estimated with Mplus version 6 (Muthen and Muthen, 1998-2010). Because there is no analytic solution to the proper number of profiles retained by LCA, models with varying numbers of classes must be evaluated on comparative fit and conceptual meaning. For these analyses, comparative fit was evaluated with the sample size–adjusted Bayesian Information Criterion (aBIC) and the Vuong-Lo-Mendell-Rubin likelihood ratio test (LRT) (Lo, Mendell, & Rubin, 2001) to determine the optimal number of classes to retain. Simulation studies have shown these indicators to be adequate tests of comparative models (Nylund et al., 2007). The class structure was ascertained as a conditional LCA model in which class membership was predicted by the variables noted above. Class assignment is more accurate when assessed with conditional LCA models when such models are of ultimate interest instead of simple unconditional models (Lubke & Muthen, 2007; Tueller, 2010). Models began with two classes, and an additional class was added until the models exhibited convergence problems or it was clear what the optimal model was based on the comparative fit statistics (i.e., aBIC was minimized and adding an additional class produced an *ns* LRT value). If these two indices diverged in their guidance on the number of classes to retain, priority was given to the LRT.

To address the first aim, current to past month prevalence was assessed with the exception of suicidal ideation which was assessed for past year. Two approaches were used to address the latter two specific aims: one is evaluating models based on profiles or patterns of comorbid disorders and the other is examining the relationships among risk factors and observed patterns. For specific aim 2, categorical models were estimated using latent class analysis (LCA), which attempts to group cases into a limited number of classes. Each latent class has a distinct profile or pattern of responses across variables, and models are estimated so that the relationship between items is fully explained by class membership. LCA contrasts with factor analysis, which attempts to extract groups of items that share common variance. For example, it was suggested that one class may have a high rate of depression and suicidal ideation but minimal anxiety and stressors. Another class may have high rates of depression, anxiety, and many PTSD symptoms. The latter class may be at higher risk for developing PTSD and exhibit poorer functioning in general. Due to the anticipated confounding of deployment status, profiles were estimated for deployed and nondeployed personnel separately and together. Differential likelihoods of class membership were tested based on deployed and nondeployed personnel types to explore how this might affect the number and pattern of mental health risks exhibited.

For specific aim 3, rates of disorder classes were estimated by different risk factors to permit an examination of whether certain classes (e.g., PTSD with alcohol abuse) vary by demographic risk factors. For example, it was hypothesized that exhibiting both PTSD and alcohol abuse may be more prevalent among men because men are more likely to have externalizing disorders. However, women may be more likely to have both PTSD with major depression. The relationship of risk factors to comorbidity profiles was tested with conditional LCA in which class membership was simultaneously predicted by each of the demographic

factors. This model identified the most important variables that differentiated the comorbidity profiles. This approach also informs future research projects about those items that are important to include or exclude based on the variance that they account for, as well as those items that are in the classes but account for very little of the observed variance.

Results

Prevalence of comorbid conditions

The unadjusted prevalence rates of each mental health measure are shown in Table 1 by gender and deployment status. Overall, women were significantly more likely than men to meet screening criteria for depression, generalized anxiety, and serious psychological distress. Women who had *not* been deployed were also more likely than men who were not deployed to meet screening criteria for PTSD. Regardless of deployment, men were more likely to meet criteria for problem drinking. Table 2 shows the distribution of the additional number of positive screens with PTSD. Almost 32% of personnel who met screening criteria for PTSD (30.6% of men and 38.7% of women) also met criteria for at least one other of the five measured mental health problems. Regardless of deployment, women screening positive for PTSD were more likely than men with PTSD to meet criteria for multiple mental health problems. As shown in Table 3, depression was the most frequent comorbid condition with PTSD symptoms: almost 75% of personnel meeting criteria for PTSD with a comorbid condition also met criteria for depression. This was closely followed by serious psychological distress and generalized anxiety. Almost 18% of personnel meeting criteria for current PTSD symptoms also reported suicidal ideation within the past year. This percentage did not vary significantly by gender or deployment status.

Latent class models

The aBIC and LRT significance tests are summarized in Table 4. The two indices did not agree on the optimal class structure for deployed personnel, with the aBIC failing to reach a minimum value at six (i.e., six classes), despite a nonsignificant LRT for six classes compared to five. However, changes in aBIC were very small for these models, so the LRT results were used to select the model with five classes described below for deployed personnel. The aBIC and LRT

were in agreement for nondeployed personnel: both criteria selected the four-class model described below. Figures 1 and 2 show the estimated probabilities of endorsing each of the six indicator items for deployed and nondeployed personnel. Overall, the class structure and response probabilities are quite similar, with all four of the nondeployed classes replicated in the deployed model.

The most prevalent class for both groups (59% deployed, 63% nondeployed) exhibited a very low likelihood of any problems. This was the referent class for estimating the influence of the various class predictors and is referred to subsequently as REF. The second most prevalent class for nondeployed personnel (20%) was characterized by relatively high risk for depression (about a 45% probability). This depression class, DEP, also had elevated likelihood for anxiety problems and K6 scores above cutoff. Other problems were relatively unlikely to be present. The deployed group also displayed a profile matching this class with two notable differences: it was much smaller (only 13.1% of deployed personnel) and was unlikely to have anxiety problems comorbid with depression. Deployed personnel displayed an additional group, termed ANX, which was characterized by elevated likelihood for anxiety problems with nearly the same probability of comorbid depression. Problems indicated by the K6 were somewhat lower but still at about 25%, and other problems were unlikely for this class, which accounted for 10.5% of deployed personnel. Both deployed and nondeployed groups shared the next profile, referred to as PTSD, which was characterized by extremely high likelihoods of problems with anxiety, depression, K6, and also PTSD. Risk for suicidal ideation was highest in this profile, and alcohol problems were are also quite prevalent. The PTSD class was the most probable class assignment for 10.7% of deployed personnel and 8.8% of nondeployed personnel. The final profile extracted by the LCA models was one largely reflective of alcohol problems. Mental health indicators

were not greatly elevated in this ALC profile, but the probability of problem drinking was quite high (about 70% of deployed personnel and 45% of nondeployed personnel). This alcohol-related profile was the smallest for both the deployed (6.9%) and nondeployed (8%) groups. Note that the names given to these classes—PTSD, ALC, DEP, etc.—are strictly for ease of reference and characterize the most salient features of each class. They should not be construed to indicate that each class is exclusively related to the mental health outcome in the name.

Predictors of class membership

For clarity of presentation, the relationships of predictor variables are organized and discussed by latent class or profile of comorbidity patterns. Due to the number of significant parameters, estimates (both logistic regression weights and odds ratios) and significance values are not included in the text but may be found in Tables 5 and 6.

PTSD. There was a great deal of commonality in predictors of class membership for the deployed and nondeployed groups. For all personnel, factors associated with increased likelihood of membership in the PTSD class (relative to the referent, low-problem class) included work and family stress, activity limitations because of mental health issues, avoidant coping style, greater impulsivity, a history of abuse, and major life stressors. Members of the Marine Corps were also at enhanced risk of being in the PTSD class. Several predictors were also associated with lower likelihood of falling into the PTSD profile, including being male, active coping, and getting more than 4 hours of average nightly sleep.

Deployed personnel showed an increase in the likelihood of membership in the PTSD class if they reported experiencing high combat exposure. Unlike nondeployed personnel, there was an increased risk of this class for Hispanic personnel and those who reported activity limitations as a result of physical health problems.

Whereas Marine Corps membership was the only service related to increased PTSD class membership for deployed personnel, nondeployed personnel were at increased risk for all services compared to the Air Force (the referent service branch).

DEP. The pattern of predictive relationships for the DEP class was also quite similar across deployment and nondeployment, and many of the same variables were significant as for PTSD. For all personnel, increased likelihood of membership in this profile was associated with work and family stress, activity limitations due to mental health, avoidant coping, history of abuse, major stressors, and impulsivity. Risk was also elevated for nondeployed personnel who were enlisted or in the Marines and for non-Hispanic deployed minorities. Active coping was a significant protective factor for both deployed and nondeployed personnel. Nondeployed personnel also showed lower risk if they were older, male, and got more than 4 hours of average nightly sleep.

ALC. Risk factors for membership in the elevated alcohol use profile for all personnel were family stress, mental health–related activity limitations, being male, serving in the Marine Corps, and avoidant coping. For nondeployed personnel, added risks included work stress and physical health limitations. High combat exposure also significantly increased the likelihood of deployed personnel being members of the ALC profile. Older personnel and active coping were significantly related to lower risk of being in this class for all personnel. Getting more than 4 hours of average nightly sleep was also protective for nondeployed personnel.

ANX. Compared to the low disorder reference profile, risk factors for this deployed-only class were work and family stress, physical health activity limitations, history of abuse, and avoidant coping. Men were significantly less likely to be in this profile, as were those with greater active coping and those who got 7 or more hours of average nightly sleep.

Discussion

This study examined the comorbidity of five mental health problem indicators among a large representative sample of active duty military personnel who met screening criteria for PTSD. To our knowledge, this is the most comprehensive study of PTSD comorbidity among active duty military personnel to date. Results have shown that almost one-third of all current personnel who screened positive for PTSD also reported at least one of the other five measured mental health problems. Separate comorbidity patterns were modeled with LCA for deployed and nondeployed personnel with five patterns or classes emerging for deployed and four patterns emerging for nondeployed personnel. Patterns were distinguished by several unique risk and/or protective factors.

The overall comorbidity rate is similar to results from the Iowa Gulf War Study, which found that over 35% of Gulf War veterans with a current mental disorder as defined using the SCID-IV had at least one other comorbid mental disorder.[30] However, the overall comorbidity rate was lower than the 50% of Vietnam veterans examined in the RTI–Department of Veterans Affairs study that met criteria for another disorder as measured with the Diagnostic Interview Schedule.[31] In that study, substance abuse and antisocial personality disorder were the highest comorbid rates and included obsessive compulsive disorder, which is not included in the present study. The difference in patterns between deployed and nondeployed personnel indicated an additional set of symptom profiles centered around anxiety among deployed personnel.

Methodological limitations of the present study include those generally inherent in other large cross-sectional surveys such as reliance on self-reported symptoms and behaviors and inability to determine the temporal and/or causal sequence of modeled predictors to outcome variables. Although the most frequent mental health diagnoses in the active duty military were

screened for, other mental health problems—such as antisocial personality disorders, phobias, panic, and obsessive compulsive disorders, which have been associated with PTSD comorbidity in civilian and veterans samples—were not included here.[1,32]

Although this is not a causal study, the observed comorbid patterns may shed further light on some of the theoretical explanations for PTSD comorbidity. For example, the high levels of responses to the anxiety, depression, serious psychological distress, and PTSD in the PTSD pattern is consistent with the global level of distress explanation; the pattern with high alcohol abuse with PTSD but lower levels of other mental health problems (ALC profile) is consistent with a self-medication hypothesis; and the patterns with highest depression or anxiety only (ANX, DEP) with PTSD is consistent with a symptom overlap hypothesis. The lack of the anxiety pattern (ANX) among nondeployed personnel may also reflect the contribution of deployment stress to PTSD comorbidity among active duty personnel. These explanations are further evidenced by the risk profiles showing a high risk for work stress (OR = 7.57) among deployed personnel with the anxiety patterns, by the high avoidant coping risk among those showing high alcohol pattern, and by the very high risk of functional impairment (usual activities limited by mental health) among those with the PTSD patterns (OR = 37.60 in deployed personnel and 27.58 in nondeployed personnel). These patterns also suggest ways in which treatment approaches, including pharmacological interventions, may be targeted to PTSD comorbidity subgroups. Longitudinal studies are needed to provide additional clarification and confirmation of these individual PTSD comorbidity patterns.

This study advances our understanding of the prevalence of co-occurring disorders with PTSD, and how individual and military factors may influence both the risk of PTSD and co-occurring mental and substance use disorders. Past efforts have typically examined PTSD with

limited consideration of other mental and substance use disorders that may contribute to its onset, duration, and disability. This research is innovative and represents the first in-depth modeling of active duty personnel that suggests hypotheses and offers preliminary data for new studies and interventions related to PTSD.

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Table 1. Prevalence Rates of Positive Screens for PTSD with Other Psychiatric Disorders in the 2008 HRB Survey, by Gender and Deployment Status

Psychiatric Disorder	Total	Males	Females	OR*	LCL	UCL
Full Sample						
PTSD	10.6 (0.54)	10.4 (0.61)	11.7 (0.55	1.14	0.99	1.31
Depression	21.1 (0.56	20.3 (0.64)	25.6 (0.81)	1.35	1.22	1.50
GAD	14.0 (0.54)	13.2 (0.64)	19.3 (0.74)	1.58	1.37	1.82
Serious psychological distress	14.3 (0.54)	13.4 (0.62)	20.0 (1.00)	1.61	1.39	1.88
Suicidal ideation,	4.6 (0.20)	4.5 (0.20)	5.1 (0.41)	1.14	0.96	1.36
Problem drinking	3.7 (0.33)	4.1 (0.37)	1.5 (0.21)	0.35	0.25	0.49
Deployed in Past Year Only						
PTSD	11.8 (0.85)	11.7 (0.92)	12.4 (0.84)	1.06	0.86	1.31
Depression	22.0 (0.76)	21.5 (0.81)	26.8 (1.10)	1.34	1.19	1.50
GAD	15.1 (0.74)	14.6 (0.81)	19.7 (1.03)	1.44	1.22	1.71
Serious psychological distress	15.0 (0.81)	14.3 (0.89)	20.8 (1.28)	1.58	1.30	1.90
Suicidal ideation,	4.6 (0.29)	4.6 (0.28)	5.2 (0.65)	1.13	0.90	1.43
Problem drinking	4.4 (0.44)	4.7 (0.48)	2.1 (0.47)	0.43	0.25	0.73

Table 1. Prevalence Rates of Positive Screens for PTSD with Other Psychiatric Disorders in the 2008 HRB Survey, by Gender and Deployment Status (cont.)

Psychiatric Disorder	Total	Males	Females	OR*	LCL	UCL
Nondeployed only						
PTSD	9.3 (0.34)	8.9 (0.37)	10.9 (0.77)	1.23	1.05	1.50
Depression	20.0 (0.44)	18.9 (0.46)	24.9 (1.08)	1.43	1.27	1.61
GAD	12.8 (0.44)	11.5 (0.48)	18.8 (1.17)	1.78	1.50	2.12
Serious psychological distress	13.7 (0.45)	12.4 (0.45)	19.4 (1.26)	1.71	1.45	2.02
Suicidal ideation	4.3 (0.23)	4.2 (0.26)	4.8 (0.38)	1.14	0.94	1.39
Problem drinking	2.8 (0.25)	3.2 (0.30)	1.2 (0.17)	0.37	0.27	0.53

*Male as referent; LCL= lower confidence limits, UCL= upper confidence limits; Confidence limits for alpha = 0.05

Table 2. Comorbidity of Number of Positive Screens for PTSD with Other Psychiatric Disorders in the 2008 HRB Survey, by Gender and Deployment Status

Number of screens	Total	Males	Females	OR*	LCL	UCL
Full Sample						
0	68.2 (0.76)	69.4 (0.87)	61.3 (1.23)	0.70	0.62	0.79
1	15.1 (0.32)	14.8 (0.33)	16.8 (0.82)	1.16	1.03	1.31
2	7.0 (0.23)	6.5 (0.25)	9.6 (0.52)	1.52	1.32	1.75
3	4.3 (0.20)	4.1 (0.21)	5.7 (0.37)	1.44	1.24	1.66
4	3.8 (0.23)	3.6 (0.26)	4.9 (0.32)	1.37	1.13	1.67
5+	1.7 (0.17)	1.6 (0.20)	1.7 (0.20)	1.01	0.71	1.47
Deployed in Past Year Only						
0	65.7 (1.14)	66.5 (1.28)	59.0 (1.18)	0.73	0.63	0.84
1	15.6 (0.54)	15.4 (0.57)	17.2 (1.23)	1.14	0.95	1.37
2	8.0 (0.43)	7.6 (0.47)	11.3 (0.81)	1.55	1.27	1.88
3	4.7 (0.27)	4.6 (0.30)	5.4 (0.46)	1.20	0.97	1.48
4	4.0 (0.30)	3.9 (0.33)	5.1 (0.54)	1.31	0.98	1.75
5+	2.0 (0.22)	2.0 (0.25)	2.0 (0.49)	0.99	0.55	1.80

Table 2. Comorbidity of Number of Positive Screens for PTSD with Other Psychiatric Disorders in the 2008 HRB Survey, by Gender and Deployment Status (cont.)

Number of screens	Total	Males	Females	OR*	LCL	UCL
Nondeployed Only						
0	69.6 (0.68)	71.2 (0.64)	62.2 (1.80)	0.67	0.58	0.76
1	14.8 (0.48)	14.4 (0.48)	16.7 (1.06)	1.19	1.03	1.38
2	6.4 (0.30)	5.9 (0.32)	8.8 (0.70)	1.55	1.27	1.89
3	4.0 (0.26)	3.6 (0.25)	6.0 (0.57)	1.72	1.41	2.10
4	3.8 (0.30)	3.6 (0.35)	4.9 (0.38)	1.39	1.07	1.79
5+	1.4 (0.15)	1.4 (0.18)	1.5 (0.22)	1.05	0.70	1.57

* Males as referent. LCL= lower confidence limits, UCL= upper confidence limits; Confidence limits for alpha = 0.05

Screens = 5 and 6 combined due to deficient cells for screens = 6.

Table 3. Percentage of Comorbid Conditions for Those with Likely PTSD in the 2008 HRB Survey, by Gender And Deployment Status

	Total	Males	Female	OR*	LCL	UCL
Full Sample						
Depression	74.5 (1.04)	74.1 (1.15)	76.7 (2.00)	1.15	0.90	1.47
GAD	63.1 (1.21)	62.1 (1.38)	68.6 (2.02)	1.34	1.09	1.64
Serious psychological distress	65.2 (1.4)	64.5 (1.72)	68.8 (2.04)	1.21	0.93	1.58
Suicidal ideation	17.7 (0.68)	17.44 (0.75)	18.8 (2.11)	1.10	0.80	1.50
Problem drinking	14.1 (1.55)	15.4 (1.70)	6.9 (1.63)	0.40	0.23	0.70
Deployed in Past Year Only						
Depression	73.1 (1.64)	72.8 (1.76)	75.6 (3.33)	1.16	0.78	1.72
GAD	61.1 (1.60)	60.9 (1.72)	62.9 (2.82)	1.09	0.83	1.41
Serious psychological distress	63.7 (1.58)	63.7 (1.91)	63.5 (3.80)	0.99	0.95	1.52
Suicidal ideation	17.5 (1.32)	17.5 (1.32)	17.4 (3.80)	0.99	0.58	1.69
Problem drinking	16.2 (1.73)	16.8 (1.82)	11.1 (3.04)	0.61	0.33	1.14

Table 3. Percentage of Comorbid Conditions for Those with Likely PTSD in the 2008 HRB Survey, by Gender And Deployment Status (cont.)

	Total	Males	Female	OR*	LCL	UCL
Nondeployed Only						
Depression	76.5 (1.57)	76.1 (1.88)	78.0 (2.58)	1.11	0.77	1.60
GAD	64.8 (1.82)	63.2 (2.36)	70.7 (3.13)	1.40	0.94	2.09
Serious psychological distress	67.1 (1.90)	65.6 (2.43)	72.5 (2.27)	1.38	0.99	1.91
Suicidal ideation	17.7 (1.15)	17.3 (1.53)	19.3 (1.89)	1.14	0.79	1.66
Problem drinking	11.4 (1.55)	13.1 (1.90)	4.7 (1.21)	0.32	0.16	0.64

* Males as referent. LCL= lower confidence limits, UCL= upper confidence limits; Confidence limits for alpha = 0.05.

NOTE: N~314.

Table 4. Fit Statistics for LCA Models

Classes	Deployed		Nondeployed	
	aBIC	**LRT *p* value**	**aBIC**	**LRT *p* value**
2	32,008.089	$p < 0.001$	41,143.450	$p < 0.001$
3	30,818.500	$p < 0.001$	39,728.637	$p < 0.001$
4	30,441.595	$p < 0.001$	39,332.552	$p < 0.001$
5	30,381.108	$p < 0.01$	39638.783	*ns*
6	30,300.228	*ns*		
7	30,281.710	*ns*		

ns = not significant

Table 5. Conditional Model Parameters, Deployed Personnel

	PTSD vs. REF	**OR**	**DEP vs. REF**	**OR**	**ALC vs. REF**	**OR**	**ANX vs. REF**	**OR**
Work stress	2.106***	8.22	0.591**	1.81	0.141	1.15	2.024**	7.57
Family stress	1.422***	4.15	1.314***	3.72	0.739*	2.09	0.828***	2.29
Mental health activity limitations	3.627***	37.60	2.561***	12.95	1.333***	3.79	1.282	3.60
Physical health activity limitation	0.530*	1.70	-0.516	0.60	0.392	1.48	1.024**	2.78
30 years or older	-0.265	0.77	-0.332	0.72	-1.095***	0.33	-0.394	0.67
Male	-0.651*	0.52	-0.512	0.60	1.032***	2.81	-0.757*	0.47
Other race/ethnicity	0.510	1.67	0.670**	1.95	-1.030*	0.36	-0.707	0.49
Hispanic	0.587**	1.80	0.413	1.51	0.437	1.55	-0.168	0.85
African American	0.082	1.09	0.374	1.45	-0.010	0.99	-0.386	0.68
Army	0.142	1.15	0.107	1.11	0.057	1.06	0.331	1.39
Navy	0.132	1.14	0.316	1.37	0.400	1.49	0.051	1.05
Marines	0.623**	1.86	0.497	1.64	0.813**	2.25	0.420	1.52

Table 5. Conditional Model Parameters, Deployed Personnel (cont.)

	PTSD vs. REF	**OR**	**DEP vs. REF**	**OR**	**ALC vs. REF**	**OR**	**ANX vs. REF**	**OR**
Air Force	Ref	1.00	Ref	1.00	Ref	1.00	Ref	1.00
Enlisted	-0.111	0.89	-0.021	0.98	0.436	1.55	-0.144	0.87
Moderate or greater impulsivity	1.882***	6.57	0.983**	2.67	1.759***	5.81	0.282	1.33
7+ hours sleep	-1.769***	0.17	0.103	1.11	-0.473*	0.62	-2.803*	0.06
5–6 hours sleep	-1.603***	0.20	0.189	1.21	-0.267	0.77	-1.159**	0.31
Active coping	-0.892***	0.41	-0.423**	0.66	-1.044***	0.35	0.124	1.13
Avoidant coping	3.155***	23.45	1.654***	5.23	2.300***	9.97	0.781**	2.18
History of abuse	1.248***	3.48	0.822***	2.28	0.350*	1.42	0.559*	1.75
Major life stressors	1.726***	5.62	1.554***	4.73	0.355	1.43	0.117	1.12
Moderate combat exposure	0.098	1.10	-0.495	0.61	-0.074	0.93	0.437	1.55
High combat exposure	0.820***	2.27	-0.078	0.92	0.475*	1.61	0.301	1.35

* = P < .05; ** = P < .10; *** = P < .001

Table 6. Conditional Model Parameters, Nondeployed Personnel

	PTSD vs. REF	**OR**	**DEP vs. REF**	**OR**	**ALC vs. REF**	**OR**
Work stress	1.720***	5.58	0.996***	2.71	0.471*	1.60
Family stress	1.338***	3.81	1.151***	3.16	0.729***	2.07
Mental health activity limitations	3.317***	27.58	1.987***	7.29	1.173***	3.23
Physical health activity limitation	0.233	1.26	0.282	1.33	0.550*	1.73
30 years or older	-0.169	0.84	-0.338**	0.71	-1.181***	0.31
Male	-0.990***	0.37	-0.857***	0.42	1.135***	3.11
Other race/ethnicity	-0.124	0.88	-0.126	0.88	0.019	1.02
Hispanic	0.014	1.01	-0.121	0.89	0.390	1.48
African American	-0.419	0.66	-0.105	0.90	0.196	1.22
Army	0.523***	1.69	0.143	1.15	0.470	1.60
Navy	0.457**	1.58	0.038	1.04	0.364	1.44
Marines	1.280***	3.60	0.324*	1.38	1.278**	3.59
Air Force		1.00		1.00		1.00

Table 6. Conditional Model Parameters, Nondeployed Personnel (cont.)

	PTSD vs. REF	**OR**	**DEP vs. REF**	**OR**	**ALC vs. REF**	**OR**
Enlisted	0.369	1.45	0.346*	1.41	-0.125	0.88
Moderate or greater Impulsivity	1.827***	6.22	0.716***	2.05	1.600***	4.95
7+ hours sleep	-2.828***	0.06	-1.453***	0.23	-1.178**	0.31
5–6 hours sleep	-1.899***	0.15	-0.938***	0.39	-0.718*	0.49
Active coping	-0.745***	0.47	-0.355***	0.70	-1.120***	0.33
Avoidant coping	2.334***	10.32	1.083***	2.95	2.441***	11.48
History of abuse	1.137***	3.12	-0.700***	0.50	0.542**	1.72
Major life stressors	2.808***	16.58	1.346***	3.84	-0.089	0.91

* = P < .05; ** = P < .10; *** = P < .001

Figure 1. Response Probabilities by Class, Deployed Personnel

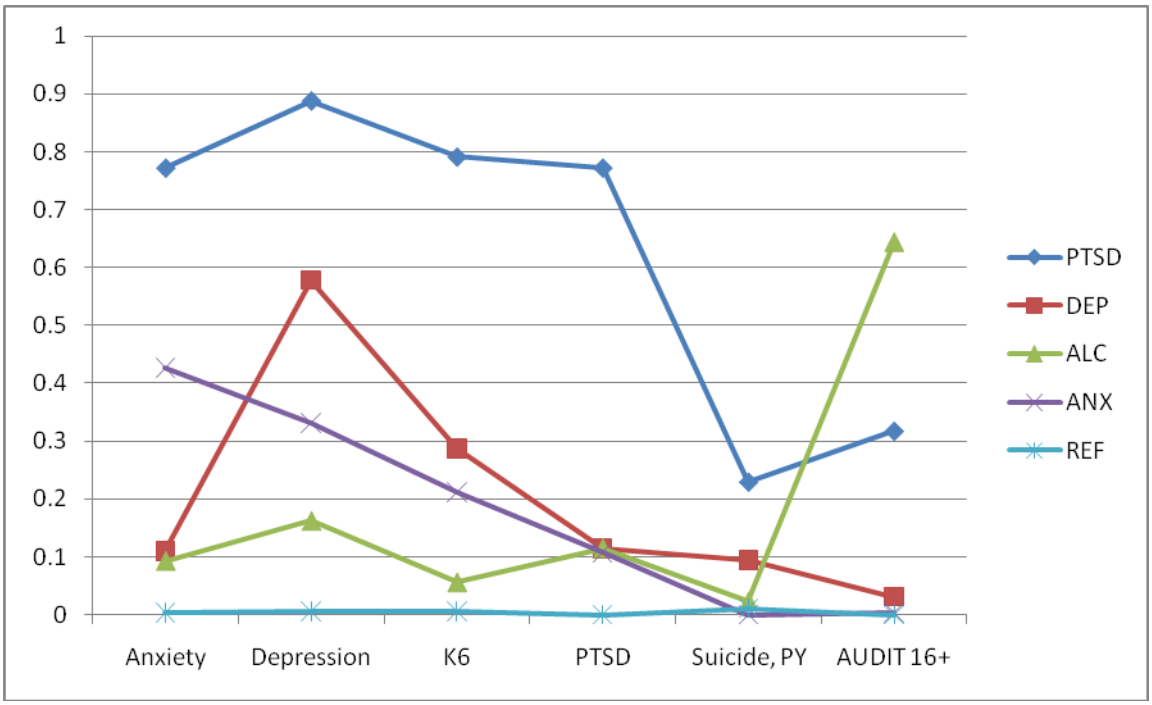
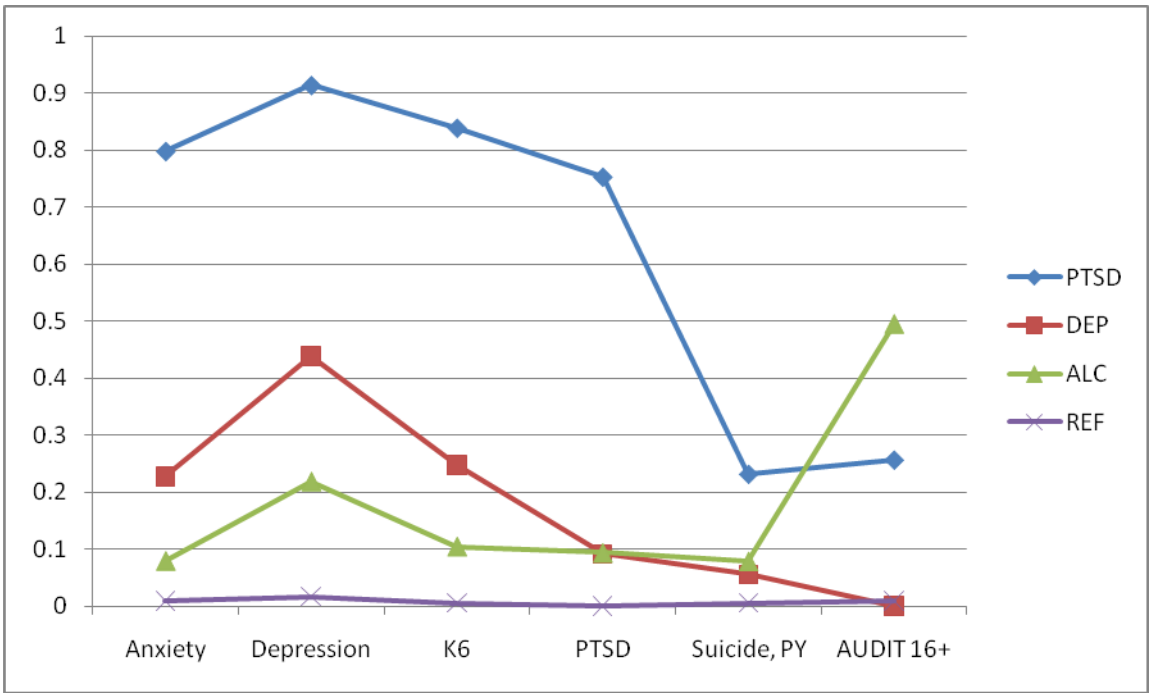


Figure 2. Response Probabilities by Class, Nondeployed Personnel



APPENDIX 6

APHA Presentation

Mental Health and Substance Abuse Comorbidities of Deployed and Nondeployed Military Personnel with Current PTSD Symptoms

Laurel L Hourani, PhD, MPH*; Jason Williams, PhD; and Robert Bray, PhD • RTI International, Research Triangle Park, NC

Abstract

Context: Deployment and trauma are associated with a number of mental health problems experienced by military personnel. Many of these co-occur, including posttraumatic stress disorder (PTSD), depression, suicidal ideation and attempt, alcohol and drug abuse, and anxiety. Although some of these comorbidities may be associated with combat-related traumas, others may be more associated with separate noncombat risk and protective factors. Such comorbidities pose increased treatment challenges; however, the prevalence and pattern of these comorbidities within the military are unknown.

Objective: To (1) describe the prevalence and underlying structure of PTSD comorbid mental health conditions among active duty military personnel

Design: Population-based, cross-sectional, anonymous survey

Setting: 64 U.S. military installations worldwide

Participants: 28,546 active duty military respondents from all branches of services stratified by gender, rank, and location

Main Outcome Measures: Categorical models of comorbid PTSD conditions, including depression, generalized anxiety, serious psychological distress, suicidal ideation, and problem drinking

Results: Almost 32% of personnel who met criteria for PTSD also met criteria for at least one of five other mental health problems; 75% of those with depression symptoms also met criteria for at least one of the other mental health problems. Latent class analysis models identified five classes of PTSD comorbidity among deployed personnel and four classes among nondeployed personnel. Separate profiles of risk and protective factors differentiated comorbid classes.

Conclusion: Findings advance our understanding of the prevalence of co-occurring disorders with PTSD and how individual and military factors may influence both the risk of PTSD and co-occurring mental and substance use disorders.

1. Introduction/Background

Posttraumatic stress disorder (PTSD) has been associated with comorbidity of many somatic and mental disorders.[1,2] Approximately 80% of people with PTSD have a co-occurring psychiatric disorder at some time in their life.[3] Understanding PTSD comorbidity is especially important for military personnel who are at high risk for PTSD and other combat-related mental disorders. In 2008, approximately 11% of the U.S. active duty military population met screening criteria for PTSD symptoms, 21% screened positive for depression symptoms, 14% met criteria for generalized anxiety disorder, and 20% reported heavy alcohol use.[12] Although these individual prevalence rates of selected mental health symptom measures have been estimated, the prevalence and pattern of their comorbidities within the total force have not been examined. Although some of these comorbidities may be associated with combat-related traumas, others may be more associated with separate noncombat risk and protective factors such as childhood trauma, cognitive abilities, sociodemographic factors, or genetic factors. Such comorbidities also pose increased treatment challenges, especially for a vulnerable population that already tends to underutilize treatment services.[13]

Because different patterns may represent different underlying etiologies, optimal intervention and treatment efforts need to take them into account. These efforts require two concurrent lines of investigation: (a) identification of multiple patterns of disorders and (b) examination of risk and protective factors for each disorder pattern. This study is the first to examine both critical lines of investigation in a large population-based representative sample of active duty military personnel with multiple standardized mental health screening measures and a wide range of potential risk and protective factors.

2. Objective

The overriding goal of this research was to develop models of PTSD comorbidity risk from a wide array of deployment, stress, trauma, and mental health factors that will help guide future research hypotheses, treatment approaches, and interventions. Three specific aims were addressed: (1) describe the prevalence of PTSD comorbid mental health conditions among active duty military personnel, (2) identify the underlying structure of co-occurring PTSD with substance use and mental disorders, and (3) examine variation in the underlying structure across subgroups defined by military characteristics (e.g., service, deployment experience, pay grade) and individual characteristics (e.g., psychosocial stressors, age, race/ethnicity, gender, education).

3. Methods

In-depth secondary analyses of the 2008 Department of Defense (DoD) Survey of Health Related Behaviors Among Active Duty Military Personnel (HRB Survey) were conducted to address the specific aims of the study. Of 35,221 sampled DoD (non-Coast Guard) service members, the 2008 HRB Survey consisted of 24,690 survey respondents stratified by pay grade, gender, and location representing the total active force (5,927Army, 6,637 Navy, 5,117 Marine Corps, and 7,009 Air Force). A two-stage replacement cluster sample proportional to size was employed in which geographic areas were clustered and randomly selected in the first stage and individuals within the clusters were randomly selected in the second stage. The response rate was 70.6%, and data were weighted to represent all active duty personnel and adjust for nonresponse. The majority (97%) of the 32-page anonymous self-report questionnaires were obtained during on-site visits by the study team. The rest were obtained from questionnaires mailed to respondents who were unable to attend group sessions.

Measures

Variables were used either as indicators of the PTSD comorbidity profiles or as factors hypothesized to predict class or profile membership. An item asking about how many deployments a respondent had had in the past year was used to divide the sample into deployed and nondeployed groups. See tables for mental health outcome screening instruments.

Predictor variables for class membership. Comorbidity profile membership was conditioned on a variety of demographic and military-related factors. Demographics included service branch (Army, Navy, Marine Corps, or Air Force), race/ethnicity (white non-Hispanic, African American non-Hispanic, Hispanic, other), age (17–29, 30 and older), and gender. Other measures from the HRB surveys included: several indicators of work and family stress, indicator of physical abuse/mistreatment from childhood , sleep quantity, impulsivity subscale of the Risk-Taking Disposition Scale, avoidant and active coping scales.

Analysis

The primary analysis for this study was latent class analysis (LCA) to determine the number and composition of statistically and conceptually distinct classes or profiles of comorbidity in deployed and nondeployed personnel. All models were estimated with Mplus version 6.[25]

4. Results

Prevalence of Comorbid Conditions

The unadjusted prevalence rates of each mental health measure are shown in **Table 1** by gender and deployment status. Overall, women were significantly more likely than men to meet screening criteria for depression, generalized anxiety, and serious psychological distress. Women who had not been deployed were also more likely than men to meet screening criteria for PTSD. Regardless of deployment, men were more likely to meet criteria for problem drinking. **Table 2** shows the distribution of the additional number of positive screens with PTSD. Almost 32% of personnel who met screening criteria for PTSD (30% of men and 38.7% of women) also met criteria for at least one other of the five measured mental health problems. Regardless of deployment, women with PTSD symptoms were more likely than men with PTSD symptoms to meet criteria for multiple mental health problems. As shown in **Table 3**, depression was the most frequent comorbid condition with PTSD symptoms: almost 75% of personnel meeting criteria for PTSD also met criteria for depression. This was closely followed by serious psychological distress and generalized anxiety. Almost 18% of personnel meeting criteria for current PTSD symptoms also reported suicidal ideation within the past year. This percentage did not vary significantly by gender or deployment status.

Latent Class Models

Figures 1 and 2 show the estimated probabilities of endorsing each of the six indicator items for deployed and nondeployed personnel. Overall, the class structure and response probabilities are quite similar, with all four of the nondeployed classes replicated in the deployed model. Note that the names given to these classes—PTSD, ALC, DEP, etc.—are strictly for ease of reference and characterize the most salient features of each class. They should not be construed to indicate that each class is exclusively related to the mental health outcome in the name. The relationships of predictor variables are organized by latent class or profile of comorbidity patterns. Estimates and significance values are found in **Tables 4 and 5**.

Figure 1. Response Probabilities by Class, Deployed Personnel

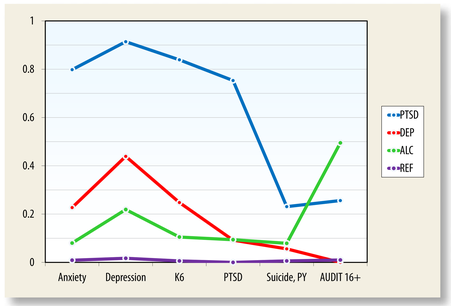
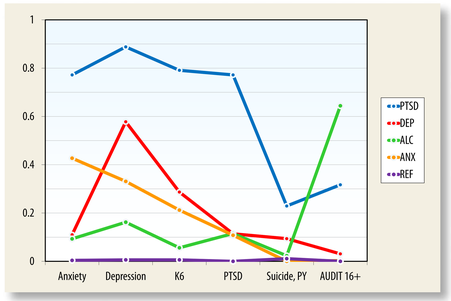


Figure 2. Response Probabilities by Class, Nondeployed Personnel



5. Discussion

This study advances our understanding of the prevalence of co-occurring disorders with PTSD, and how individual and military factors may influence both the risk of PTSD and co-occurring mental and substance use disorders. Past efforts have typically examined PTSD with limited consideration of other mental and substance use disorders that may contribute to its onset, duration, and disability. This research is innovative and represents the first in-depth modeling of active duty personnel that suggests hypotheses and offers preliminary data for new studies and interventions related to PTSD.

References available on request.

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More Information

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Tables

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Full Sample						
PTSD (PCL-C >49)	10.6 (0.54)	10.4 (0.61)	11.7 (0.55	1.14	0.99	1.31
Depression (Burnam Screen A)	21.1 (0.56)	20.3 (0.64)	25.6 (0.81)	1.35	1.22	1.50
GAD (Pt. Health Questionnaire)	14.0 (0.54)	13.2 (0.64)	19.3 (0.74)	1.58	1.37	1.82
Serious psych distress (K6)	14.3 (0.54)	13.4 (0.62)	20.0 (1.00)	1.61	1.39	1.88
Suicidal ideation, past yr	4.6 (0.20)	4.5 (0.20)	5.1 (0.41)	1.14	0.96	1.36
Problem drinking (Audit>19)	3.7 (0.33)	4.1 (0.37)	1.5 (0.21)	0.35	0.25	0.49
Deployed in Past Year Only						
PTSD (PCL-C >49)	11.8 (0.85)	11.7 (0.92)	12.4 (0.84)	1.06	0.86	1.31
Depression (Burnam Screen A)	22.0 (0.76)	21.5 (0.81)	26.8 (1.10)	1.34	1.19	1.50
GAD (Pt. Health Questionnaire)	15.1 (0.74)	14.6 (0.81)	19.7 (1.03)	1.44	1.22	1.71
Serious psych distress (K6)	15.0 (0.81)	14.3 (0.89)	20.8 (1.28)	1.58	1.30	1.90
Suicidal ideation, past year	4.6 (0.29)	4.6 (0.28)	5.2 (0.65)	1.13	0.90	1.43
Problem drinking (Audit>19)	4.4 (0.44)	4.7 (0.48)	2.1 (0.47)	0.43	0.25	0.73
Nondeployed only						
PTSD	9.3 (0.34)	8.9 (0.37)	10.9 (0.77)	1.23	1.05	1.50
Depression	20.0 (0.44)	18.9 (0.46)	24.9 (1.08)	1.43	1.27	1.61
GAD	12.8 (0.44)	11.5 (0.48)	18.8 (1.17)	1.78	1.50	2.12
Serious psychological distress	13.7 (0.45)	12.4 (0.45)	19.4 (1.26)	1.71	1.45	2.02
Suicidal ideation	4.3 (0.23)	4.2 (0.26)	4.8 (0.38)	1.14	0.94	1.39
Problem drinking	2.8 (0.25)	3.2 (0.30)	1.2 (0.17)	0.37	0.27	0.53

*Males as referent; LCL= lower confidence limits, UCL= upper confidence limits; Confidence limits for alpha = 0.05

Table 2. Comorbidity of Number of Positive Screens for PTSD with Other Psychiatric Disorders in the 2008 HRB Survey, by Gender and Deployment Status

Number of Screens	Total	Males	Females	OR*	LCL	UCL
Full Sample						
0	68.2 (0.76)	69.4 (0.87)	61.3 (1.23)	0.70	0.62	0.79
1	15.1 (0.32)	14.8 (0.33)	16.8 (0.82)	1.16	1.03	1.31
2	7.0 (0.23)	6.5 (0.25)	9.6 (0.52)	1.52	1.32	1.75
3	4.3 (0.20)	4.1 (0.21)	5.7 (0.37)	1.44	1.24	1.66
4	3.8 (0.23)	3.6 (0.26)	4.9 (0.32)	1.37	1.13	1.67
5+	1.7 (0.17)	1.6 (0.20)	1.7 (0.20)	1.01	0.71	1.47
Deployed in Past Year Only						
0	65.7 (1.14)	66.5 (1.28)	59.0 (1.18)	0.73	0.63	0.84
1	15.6 (0.54)	15.4 (0.57)	17.2 (1.23)	1.14	0.95	1.37
2	8.0 (0.43)	7.6 (0.47)	11.3 (0.81)	1.55	1.27	1.88
3	4.7 (0.27)	4.6 (0.30)	5.4 (0.46)	1.20	0.97	1.48
4	4.0 (0.30)	3.9 (0.33)	5.1 (0.54)	1.31	0.98	1.75
5+	2.0 (0.22)	2.0 (0.25)	2.0 (0.49)	0.99	0.55	1.80
Nondeployed only						
0	69.6 (0.68)	71.2 (0.64)	62.2 (1.80)	0.67	0.58	0.76
1	14.8 (0.48)	14.4 (0.48)	16.7 (1.06)	1.19	1.03	1.38
2	6.4 (0.30)	5.9 (0.32)	8.8 (0.70)	1.55	1.27	1.89
3	4.0 (0.26)	3.6 (0.25)	6.0 (0.57)	1.72	1.41	2.10
4	3.8 (0.30)	3.6 (0.35)	4.9 (0.38)	1.39	1.07	1.79
5+	1.4 (0.15)	1.4 (0.18)	1.5 (0.22)	1.05	0.70	1.57

*Male as referent; LCL= lower confidence limits, UCL= upper confidence limits; Confidence limits for alpha = 0.05

Screens = 5 and 6 combined due to deficient cells for screens = 6.

Table 3. Percentage of Comorbid Conditions for Those with Likely PTSD in the 2008 HRB Survey, by Gender And Deployment Status

Comorbid Conditions	Total	Males	Females	OR*	LCL	UCL
Full Sample						
Depression	74.5 (1.04)	74.1 (1.15)	76.7 (2.00)	1.15	0.90	1.47
GAD	63.1 (1.21)	62.1 (1.38)	68.6 (2.02)	1.34	1.09	1.64
Serious psychological distress	65.2 (1.40)	64.5 (1.72)	68.8 (2.04)	1.21	0.93	1.58
Suicidal ideation	17.7 (0.68)	17.4 (0.75)	18.8 (2.11)	1.10	0.80	1.50
Problem drinking	14.1 (1.55)	15.4 (1.70)	6.9 (1.63)	0.40	0.23	0.70
Deployed in Past Year Only						
Depression	73.1 (1.64)	72.8 (1.76)	75.6 (3.33)	1.16	0.78	1.72
GAD	61.1 (1.60)	60.9 (1.72)	62.9 (2.82)	1.09	0.83	1.41
Serious psychological distress	63.7 (1.58)	63.7 (1.91)	63.5 (3.80)	0.99	0.95	1.52
Suicidal ideation	17.5 (1.32)	17.5 (1.32)	17.4 (3.80)	0.99	0.58	1.69
Problem drinking	16.2 (1.73)	16.8 (1.82)	11.1 (3.04)	0.61	0.33	1.14
Nondeployed only						
Depression	76.5 (1.57)	76.1 (1.88)	78.0 (2.58)	1.11	0.77	1.60
GAD	64.8 (1.82)	63.2 (2.36)	70.7 (3.13)	1.40	0.94	2.09
Serious psychological distress	67.1 (1.90)	65.6 (2.43)	72.5 (2.27)	1.38	0.99	1.91
Suicidal ideation	17.7 (1.15)	17.3 (1.53)	19.3 (1.89)	1.14	0.79	1.66
Problem drinking	11.4 (1.55)	13.1 (1.90)	4.7 (1.21)	0.32	0.16	0.64

*Male as referent; LCL= lower confidence limits, UCL= upper confidence limits; Confidence limits for alpha = 0.05

NOTE: N=314.

Table 4. Conditional Model Parameters, Deployed Personnel

	PTSD vs. REF	OR	DEP vs. REF	OR	ALC vs. REF	OR	ANX vs. REF	OR
Work stress	2.106***	8.22	0.591**	1.81	0.141	1.15	2.024**	7.57
Family stress	1.422***	4.15	1.314***	3.72	0.739*	2.09	0.828***	2.29
Mental health activity limitations	3.627***	37.60	2.561***	12.95	1.333***	3.79	1.282	3.60
Physical health activity limitation	0.530*	1.70	-0.516	0.60	0.392	1.48	1.024**	2.78
30 years or older	-0.265	0.77	-0.332	0.72	-1.095***	0.33	-0.394	0.67
Male	-0.651*	0.52	-0.512	0.60	1.032***	2.81	-0.757*	0.47
Other race/ethnicity	0.510	1.67	0.670**	1.95	-1.030*	0.36	-0.707	0.49
Hispanic	0.587**	1.80	0.413	1.51	0.437	1.55	-0.168	0.85
African American	0.082	1.09	0.374	1.45	-0.010	0.99	-0.386	0.68
Army	0.142	1.15	0.107	1.11	0.057	1.06	0.331	1.39
Navy	0.132	1.14	0.316	1.37	0.400	1.49	0.051	1.05
Marines	0.623**	1.86	0.497	1.64	0.813**	2.25	0.420	1.52
Air Force	Ref	1.00	Ref	1.00	Ref	1.00	Ref	1.00
Enlisted	-0.111	0.89	-0.021	0.98	0.436	1.55	-0.144	0.87
Moderate or greater impulsivity	1.882***	6.57	0.983**	2.67	1.759***	5.81	0.282	1.33
7+ hours sleep	-1.769***	0.17	0.103	1.11	-0.473*	0.62	-2.803*	0.06
5–6 hours sleep	-1.603***	0.20	0.189	1.21	-0.267	0.77	-1.159**	0.31
Active coping	-0.892***	0.41	-0.423**	0.66	-1.044***	0.35	0.124	1.13
Avoidant coping	3.155***	23.45	1.654***	5.23	2.300***	9.97	0.781**	2.18
History of abuse	1.248***	3.48	0.822***	2.28	0.350*	1.42	0.559*	1.75
Major life stressors	1.726***	5.62	1.554***	4.73	0.355	1.43	0.117	1.12
Moderate combat exposure	0.098	1.10	-0.495	0.61	-0.074	0.93	0.437	1.55
High combat exposure	0.820***	2.27	-0.078	0.92	0.475*	1.61	0.301	1.35

* = P < .05; ** = P < .10; *** = P < .001

Table 5. Conditional Model Parameters, Nondeployed Personnel

	PTSD vs. REF	OR	DEP vs. REF	OR	ALC vs. REF	OR
Work stress	1.720***	5.58	0.996***	2.71	0.471*	1.60
Family stress	1.338***	3.81	1.151***	3.16	0.729***	2.07
Mental health activity limitations	3.317***	27.58	1.987***	7.29	1.173***	3.23
Physical health activity limitation	0.233	1.26	0.282	1.33	0.550*	1.73
30 years or older	-0.169	0.84	-0.338**	0.71	-1.181***	0.31
Male	-0.990***	0.37	-0.857***	0.42	1.135***	3.11
Other race/ethnicity	-0.124	0.88	-0.126	0.88	0.019	1.02
Hispanic	0.014	1.01	-0.121	0.89	0.390	1.48
African American	-0.419	0.66	-0.105	0.90	0.196	1.22
Army	0.523***	1.69	0.143	1.15	0.470	1.60
Navy	0.457**	1.58	0.038	1.04	0.364	1.44
Marines	1.280***	3.60	0.324*	1.38	1.278**	3.59
Air Force		1.00		1.00		1.00
Enlisted	0.369	1.45	0.346*	1.41	-0.125	0.88
Moderate or greater Impulsivity	1.827***	6.22	0.716***	2.05	1.600***	4.95
7+ hours sleep	-2.828***	0.06	-1.453***	0.23	-1.178**	0.31
5–6 hours sleep	-1.899***	0.15	-0.938***	0.39	-0.718*	0.49
Active coping	-0.745***	0.47	-0.355***	0.70	-1.120***	0.33
Avoidant coping	2.334***	10.32	1.083***	2.95	2.441***	11.48
History of abuse	1.137***	3.12	-0.700***	0.50	0.542**	1.72
Major life stressors	2.808***	16.58	1.346***	3.84	-0.089	0.91

* = P < .05; ** = P < .10; *** = P < .001